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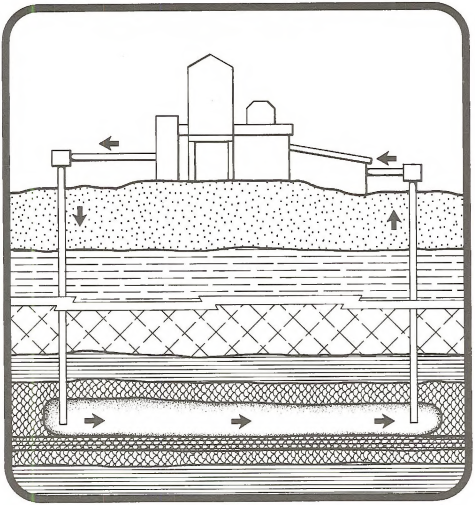
ENVIRONMENTAL IMPACT STATEMENT

WOLF RIDGE CORPORATION
MINE PLAN
FOR A
NAHCOLITE SOLUTION MINE



U.S. Department of the Interior
Bureau of Land Management
White River Resource Area
Craig District, Colorado

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July 1986

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
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Dear Reader:

This is the Draft Environmental Impact Statement (EIS) on the Wolf Ridge Corporation (WRC) Mine Plan for a Nahcolite Solution Mine. Your review and comments are invited. Please direct your written comments to:

Willy Frank, Project Coordinator
Bureau of Land Management
White River Resource Area
PO Box 928
Meeker, Colorado 81641

Also included in this document is an appendix (Appendix F) briefly describing the U.S. Environmental Protection Agency's (EPA) Underground Injection Control Program and the decisions confronting EPA regarding WRC's mine plan. This appendix is included as prepared and presented by EPA at their request and for their convenience. Your review and comments on the issues contained within this appendix are invited by EPA. Please direct these comments to:

Mark Herman, UIC Permit Coordinator
U.S. Environmental Protection Agency - Region VIII
Drinking Water Branch
One Denver Place - 999 18th St., Ste 1300
Denver, Colorado 80202-2413

Written comments must be received by close of business on September 23, 1986.

Oral and/or written comments will also be accepted at the following public meetings that will be held concerning the draft EIS.

Date and Time	City	Location
August 26, 1986 7:00 p.m.	Meeker, Colorado	White River Resource Area Office 2 miles west of Meeker
August 27, 1986 7:00 p.m.	Grand Junction, Colorado	Rodeway Inn 2790 Crossroads Blvd at Horizon Drive

Oral comments will be limited to 10 minutes and should be accompanied with a written synopsis of the comments.

If only minor modifications are required as a result of review and comment, the final EIS will incorporate this document, by reference, with any necessary modifications and corrections, record of public comments, and the responses to those comments. Therefore, reviewers may want to retain this draft EIS for use in conjunction with the final EIS.

Thank you for your continuing interest in the public lands.

Sincerely,

Bob Moore
Acting State Director

WOLF RIDGE CORPORATION

MINE PLAN FOR A NAHCOLITE SOLUTION MINE

ENVIRONMENTAL IMPACT STATEMENT

Draft (X) Final ( )

The United States Department of the Interior, Bureau of Land Management

1. Type of Action: Administrative (X) Legislative ( )

2. Abstract: This draft environmental impact statement analyzes and defines the potential environmental and socioeconomic effects of Wolf Ridge Corporation's mine plan for a 30-year, 125,000 tons per year (tpy) nahcolite solution mine on existing leases they hold in the Piceance Basin, Rio Blanco County, Colorado. In addition, this EIS identifies mitigative measures and special stipulations that will be incorporated into the approved plan. Three other alternatives are also analyzed: a 50,000 TPY Alternative, a 500,000 TPY Alternative, and a No Action Alternative.

3. For further information, contact:

Willy Frank, Project Coordinator
Bureau of Land Management
White River Resource Area
PO Box 928
Meeker, Colorado 81641

Telephone (303) 878-3601

4. Comments on the draft environmental impact statement must be received no later than: September 23, 1986.

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ENVIRONMENTAL IMPACT STATEMENT

WOLF RIDGE CORPORATION MINE PLAN

FOR A NAHCOLITE SOLUTION MINE

Prepared By:

Bureau of Land Management
U.S. Department of the Interior

Bob Moore
Acting State Director
Colorado State Office

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SUMMARY

SUMMARY

On October 9, 1984, Wolf Ridge Corporation (WRC), the holder of four federal sodium lease tracts within the Piceance Basin in northwest Colorado, submitted a mine plan to the Bureau of Land Management (BLM) for a commercial-scale nahcolite solution mine. Initial screening of the mine plan indicated that it represented a major federal action with the potential for significant impacts; therefore, pursuant to Section 102 of the National Environmental Policy Act of 1969 (NEPA), BLM determined that an environmental impact statement (EIS) would be required in conjunction with approval of the mine plan.

Four alternatives, including WRC's proposal, are described and analyzed in this EIS. The purpose of this EIS is to analyze and define the potential environmental and socioeconomic effects of each of these alternatives. In addition, the EIS identifies necessary mitigation in the form of stipulations that would be incorporated into the approved plan.

The following narrative briefly describes each of the alternatives and summarizes their anticipated impacts.

No Action Alternative

This alternative involves construction and operation of a 6-ton per year (tpy), 2-year maximum pilot-scale nahcolite mine that was analyzed and approved by BLM in an environmental assessment (EA Number CO-010-86-07) on May 2, 1986. Therefore, this action (pilot-scale mine) is independent of WRC's commercial-scale mine plan and can occur, regardless of the outcome of this EIS.

Under the No Action Alternative, the approved pilot project will take place; however, expansion of the approved pilot project to a commercial-scale project will not occur.

Facilities approved under the pilot project include: a 5-acre plant site, a 4-acre well field for in situ solution mining of nahcolite, an evaporation pond encompassing 4 acres, a new water well and ancillary pipeline, and upgrading (including graveling) of the existing access road into the plant site.

No significant adverse impacts will result from the No Action (Pilot Project) Alternative. Minor short-term impacts will occur to air quality, soils, vegetation, livestock grazing, water resources, wildlife, and recreational/visual resources. Cultural and paleontological resources will also be potentially impacted. Existing and future mineral lease rights could be complicated because of diminished surface occupancy possibilities within the project development area.

Groundwater consumed by the pilot project will contribute cumulatively to adverse alterations of downstream endangered fish habitat, although the project, by itself, will probably not jeopardize the continued existence of any listed fish. Mitigation (conservation measures) will compensate for this impact.

Proposed Action

WRC's proposal involves construction and operation of a commercial-scale nahcolite solution mine to produce sodium bicarbonate at a maximum rate of 125,000 tpy over a 30-year period. The proposal involves phased-approach development, with initial production of 50,000 tpy, increasing in the second or third year of operation to 125,000 tpy.

The Proposed Action would involve: expansion of the approved pilot project well field and plant site, paving of the access road into the plant site (affecting up to 215 additional acres), construction of additional evaporation ponds (affecting up to 22 additional acres), construction of a natural gas pipeline into the plant site (involving 17 acres), and addition of a warehouse/rail loading facility at Lacy Station in Rifle, Colorado.

The only potentially significant adverse impacts associated with this alternative would be to local groundwater quantity and quality. There would be a 5 percent reduction in average daily flow from Yellow Creek. This could be mitigated through a state required water augmentation plan. The area of the base of the lower aquifer in contact with salts would increase by approximately 20 percent within the lease tracts.

The resources described as being affected under the No Action, in most cases, would be impacted to a greater degree under this alternative because of the 30-year project life. Potential surface subsidence of less than 1 foot would also occur; however, none of these impacts would be considered significant after application of mitigation.

50,000 TPY Alternative

This alternative would involve construction and operation of a 30-year solution mine producing 50,000 tpy of sodium bicarbonate. It would essentially be an expansion of the 2-year pilot project to a 30-year commercial facility. It would involve similar, but less expansion than described under the Proposed Action, except the access road would not be paved and the Lacy Station warehouse/rail loading facility would not be utilized. Approximately 90 acres of additional land would be associated with expansion of the well field. Additional evaporation ponds would be required, affecting approximately 10 acres.

No potentially significant adverse impacts would occur under this alternative. Resource impacts would be similar, although greater than those addressed under the No Action Alternative, because of the 30-year project life. Potential surface subsidence of less than 1 foot would also occur under this alternative.

500,000 TPY Alternative

This alternative would involve construction and operation of a 30-year solution mine producing 500,000 tpy of sodium bicarbonate. It would involve: substantial expansion of the approved pilot project well field and plant site (affecting up to 818 additional acres), additional evaporation ponds (affecting up to 88 additional acres), a commercial transmission line into the plant site, bulk product loading and handling facilities on-site and at Lacy Station, and a coal-fired generator and associated facilities.

Impacts to all resources would be greatest under this alternative. Potentially significant impacts would occur to air quality, groundwater quantity and quality, cultural resources, and riparian-wetland habitat along Yellow Creek.

The environmentally preferred alternative is the No Action Alternative. BLM's preferred alternative is the Proposed Action.

1. PURPOSE AND NEED

1. PURPOSE AND NEED

1.1 Purpose and Need for the Proposed Action

Wolf Ridge Corporation (WRC) has submitted a mine plan to the Bureau of Land Management pursuant to federal regulation 43 CFR 3570. This mine plan proposes construction and operation of a commercial-scale nahcolite solution mine that will produce a maximum of 125,000 tons per year (tpy) of sodium bicarbonate over a 30-year period. The proposal is for a site-specific mining operation initially producing 50,000 tpy, with escalation in the second or third year to 125,000 tpy. WRC's four sodium leases total approximately 8,222 acres and are located within the Piceance Basin in Rio Blanco County, Colorado. Please see Map 1-1 for the general location of the sodium project area within the Piceance Basin Planning Area.

The product, sodium bicarbonate, would be produced by mining nahcolite (naturally occurring sodium bicarbonate). Currently, all sodium bicarbonate produced in the world is synthetically manufactured. WRC officials believe that they can produce the lowest cost sodium bicarbonate through solution mining; thus, they could easily penetrate the existing U.S. market, which utilizes approximately 380,000 tons per year.

1.2 Proposed Action

WRC's proposed action involves construction and operation of a commercial-scale solution mine to produce nahcolite at a maximum rate of 125,000 tpy over a 30-year period. The proposal involves phased-approach development, with initial production of 50,000 tpy increasing in the second or third year of operation to 125,000 tpy.

The proposed project includes a well field for in situ solution mining of nahcolite; a handling and processing plant; evaporation ponds; and associated transportation, access, and support facilities, including natural gas and water pipelines, access roads, and a storage/rail-loading facility at Lacy Station railhead in Rifle, Colorado.

According to WRC's current schedule, site construction would begin in early 1987, with the first production occurring in the second quarter of 1988.

For a detailed description of WRC's proposal, please refer to the narrative on the Proposed Action in Chapter 2, Description of the Alternatives.

The Proposed Action is in conformance with the current Management Framework Plan for the White River Resource Area and the proposed Resource Management Plan for the Piceance Basin. It is also consistent with state policy and local land use goals for this area.

1.3 Initiation and Purpose of the EIS

On October 9, 1984, WRC submitted a mine plan to BLM for a commercial-scale nahcolite solution mine on federal sodium leases it holds in Piceance Basin. Initial internal screening of the mine plan indicated that it represented a major federal action with the potential for significant impacts; therefore, pursuant to Section 102 of the National Environmental Policy Act of 1969 (NEPA), BLM determined that an EIS would be required in conjunction with approval of WRC's commercial-scale mine plan.

The purpose of this EIS is to analyze and define the potential environmental and socioeconomic effects of implementing the Proposed Action and a range of reasonable alternatives. In addition, the EIS is intended to identify necessary mitigation and special stipulations that would be incorporated into the approved plan.

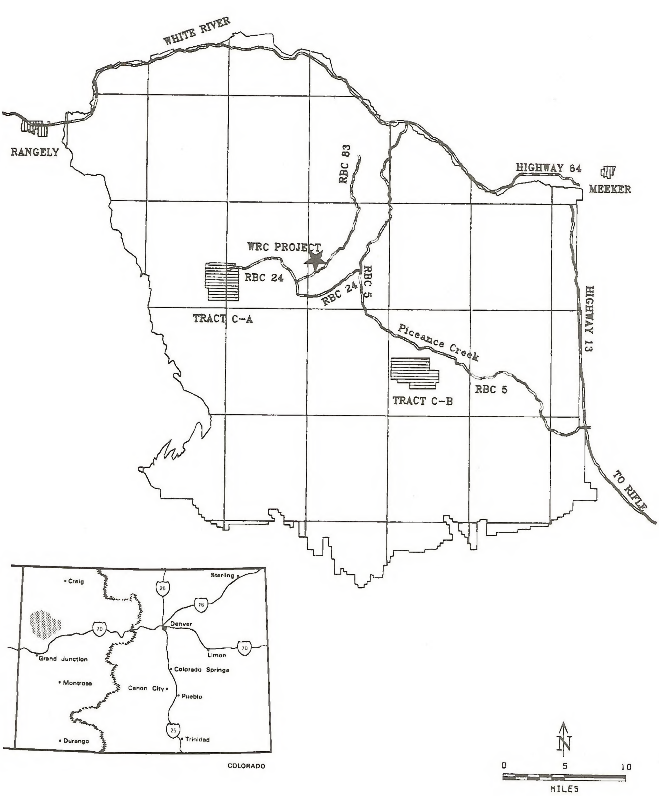
1.4 Summary of Scoping Process and Issues

Pursuant to federal regulation 40 CFR 1501.7, the scoping process involves defining significant environmental and socioeconomic issues that may result from approval of the Proposed Action. In addition, scoping helps define a range of reasonable alternatives to be analyzed along with the Proposed Action in the EIS.

The scoping process has been formal through a 30-day written comment period and through public meetings held in Meeker on June 18 and Grand Junction, Colorado, on June 19, 1985. This formal scoping period was initiated on May 31, 1985, when BLM filed a Notice of Intent in the *Federal Register* to prepare an EIS and to hold public scoping meetings. Formal scoping ended on July 1, 1985.

Informal scoping was initiated before formal scoping. This involved internal review of WRC's mine plan (Proposed Action) and direct contact by the lead BLM office with other BLM offices, other agencies, state and local government offices, and private individuals.

As a result of both informal and formal scoping, a range of reasonable alternatives was developed and major issues identified for analysis in this EIS. For a description and



GENERAL LOCATION MAP

MAP 1-1

discussion of the alternatives, please refer to Chapter 2, Proposed Action and Alternatives.

The following major issues were identified during the scoping process and have been addressed in the EIS. Under each issue is an initial statement generally describing what the issue involves. Following the general statement are a series of questions to clarify how the issue will be addressed in the EIS.

1. Hydrology

This issue addresses the potential impacts of the proposed project on surface and groundwater quality and quantity.

a. What is the existing extent of communication between the upper and lower aquifers within the project area?

b. What will be the impact of the project on local and regional groundwater quality and quantity?

c. Will contamination of the groundwater system by brines be prevented by WRC's proposed drilling, completion, and plugging program?

d. Is WRC's proposed subsidence and groundwater quality monitoring adequate?

e. What is the ability of the cavities to contain the dissolving fluid?

f. Will ash disposal into mined-out cavities impact the groundwater resources?

g. Are there alternatives to evaporation ponds for waste water disposal, and will the proposed ponds adequately handle the amounts expected?

h. How will project runoff be controlled?

i. What are the spill contingency plans and are they adequate?

j. What is the continuity and competency of the "rubber beds"? Is it an effective aquitard?

2. Oil Shale

This issue addresses the potential impacts of the proposed project on the rich oil shale resources in the area. Existing lease terms prohibit damage to the quantity, quality, or minability of the oil shale resources within the sodium lease boundaries.

a. How competent is the Mahogany Zone (R-7) within the sodium lease boundaries?

b. What effect will solution mining have on future mining of the oil shale resources?

3. Solution Mining Buffer Zones

Section 2(p) of the lease requires that where the minerals are taken from the earth in solution that " .... the location within a producing formation of an entry, well, or opening for extraction shall not be within 500 feet of the boundary line of leased lands without the permission of or unless directed by the lessor, nor shall induced fracturing extend to less than 100 feet from the boundary line." WRC is requesting in their mine plan that this 500-foot buffer width be entirely eliminated in the case of a boundary separating two contiguous leases. They also request that it be dropped to 50 feet along outside lease boundaries. These two requests will be treated as issues for identification and analysis in the EIS.

a. What impacts would occur as a result of dropping this stipulation entirely from contiguous lease boundaries?

b. What impacts would occur as a result of lowering this buffer zone to 50 feet from outside lease boundary lines?

1.5 Background

Effective July 1, 1971, four sodium preference right leases were issued as follows:

Lease No.	Owner
C-0118326	Wolf Joint Venture
C-0118327	Wolf Ridge Minerals Corporation
C-0119986	Ridge Minerals Venture
C-0119985	Rock School Joint Venture

In March 1972, lease no. C-0119985 was partitioned by the members of Rock School Joint Venture and as a result, Advance Minerals Corporation (AMC) acquired approximately 1,200 acres of land covered by that lease. In September 1972, the owners of the original lease nos. C-0118326, C-0118327, C-0119986, and AMC, as the owner of 1,200 acres of original lease no. C-0119985, assigned the leases to Utah Shale Land Corporation. On October 25, 1972, the Colorado State Office of the BLM issued a decision approving the assignments to Utah Shale Land Corporation effective November 1, 1972, and consolidating the assigned leases into one lease, number C-0118326. The Utah Shale Land Corporation instituted a name change after the consolidation of sodium lease no. C-0118326. The new corporation name became Industrial Resources, Inc. (IRI).

Effective March 1, 1980, lease no. C-0118326 was assigned from IRI to Wolf Ridge Corporation, a wholly owned subsidiary. On June 9, 1980, Multi-Minerals Corporation (MMC) acquired lease no. C-0118326 from WRC, and on September 5, 1980, MMC and WRC filed a request for approval of the assignment with the BLM Colorado State Office. While waiting for the approval, MMC conducted exploration on the lease, drilling numerous holes (11) and conducting other work. However, effective June 29, 1982, MMC assigned all interest in the lease back to WRC; shortly thereafter, MMC filed a withdrawal of its request for approval of the assignment with BLM, which was accepted effective July 7, 1982.

By decision dated April 15, 1983, consolidated sodium lease C-0118326 was reformed to comply with the Mineral Lands Leasing Act of 1920 by reestablishing the three original leases and a new lease (1,200 acres out of C-0119985). These leases, as shown in Map 1-2, are legally described as follows:

C-0118326

Township 1 South, Range 98 West, 6th Principal Meridian
Section 13: All
Section 14: All
Section 15: Lots 1 to 13 inclusive
Section 21: NE1/4NE1/4, S1/2NE1/4, NE1/4SW1/4, SE1/4
Section 22: Lots 12, 13, and 14
Total area = 2,159.64 acres

C-0118327

Township 1 South, Range 98 West, 6th Principal Meridian
Section 23: All
Section 24: All
Section 25: All
Section 26: All
Total area = 2,483.16 acres

C-0119986

Township 1 South, Range 98 West, 6th Principal Meridian
Section 21: S1/2SW1/4
Section 27: All
Section 28: All
Section 29: SE1/4NE1/4, S1/2S1/2, NE1/4SE1/4
Section 33: All
Section 34: Lots 3, 4, 5, and 6
Total area = 2,379.60 acres

C-37474 (out of C-0119985)

Township 1 South, Range 98 West, 6th Principal Meridian
Section 16: N1/2NE1/4, SW1/4NE1/4, W1/2, NW1/4SE1/4
Section 17: All
Section 20: NE1/4NE1/4
Section 21: NW1/4NW1/4
Total area = 1,200.00 acres

In February 1983, WRC contracted Cliffs Engineering, Inc., in Rifle, Colorado, to provide engineering designs and financial analyses for a nahcolite solution mine on their sodium leases. The result of this effort was development of a three-phase plan to bring the project into commercial development.

The first phase of development was a 3-ton per day bulk sampling operation, which was approved by BLM through an exploration plan. This testing phase, which ran from November 1983 to February 1984, produced in excess of 165 tons of high purity sodium bicarbonate. WRC believes that this program was successful in demonstrating the effectiveness and feasibility of their solution mining technique.

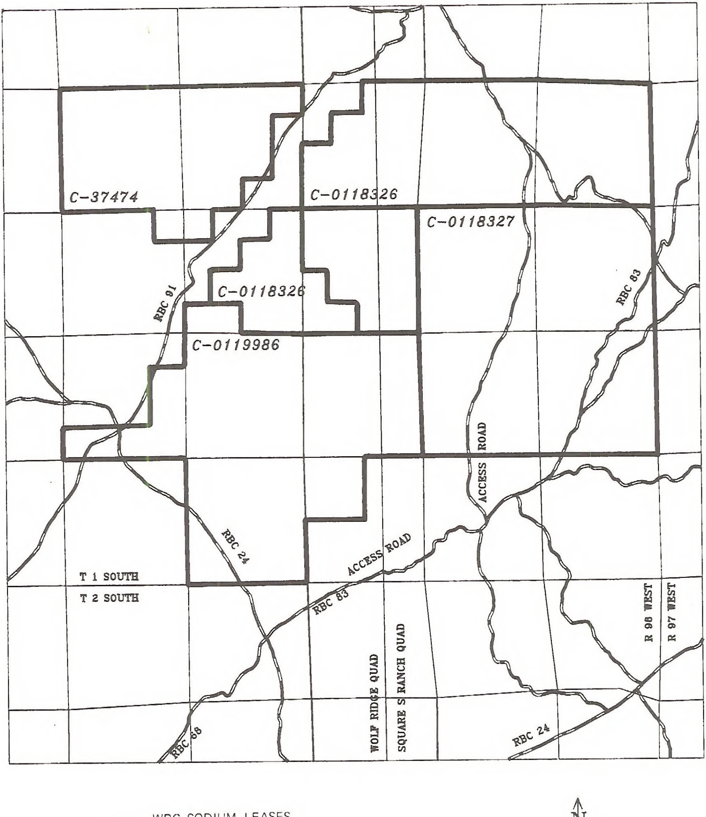
The second phase of development involves construction and operation of a 6-ton per hour pilot-scale mine. Although the original pilot mine plan was approved by BLM in February of 1984, no associated development occurred. In the summer of 1985, WRC submitted revisions to the approved pilot plant mine plan. An environmental assessment (EA No. CO-017-86-07) was completed by BLM to evaluate the revised mine plan. It was approved on May 2, 1986, subject to certain conditions. WRC projects a production start-up date in the first or second quarter of 1986. For a detailed description of the approved pilot-scale (Phase II) project, please refer to the description of the No Action Alternative in Chapter 2.

The third phase of development is the Proposed Action (125,000 TPY Commercial-Scale Nahcolite Solution Mine), which is the focus of this environmental impact statement (EIS). For a detailed description of the Proposed Action, please see Chapter 2.

1.6 Interrelationships with Other Projects

As previously stated, WRC submitted a mine plan for its second phase pilot plant development in October of 1983. Although an environmental assessment (EA) was completed and approved in February of 1984, no development ever occurred. In the summer of 1985, WRC submitted revisions to the approved pilot plant mine plan. Since the revised plans involved significant changes, including development on a different physical location than that analyzed in the original EA, a new EA was completed. This revised pilot-scale project was approved, subject to conditions, by BLM on May 2, 1986.

The Proposed Action, the 50,000 TPY, and the 500,000 TPY alternatives would all involve expansion of the approved pilot-scale project. As such, many of the facilities analyzed and approved in the Pilot Plant EA are common to the commercial-scale alternatives. Those facilities that are common to both, such as the access road, water pipeline, plant site and initial evaporation pond, are addressed and analyzed under the No Action (Pilot Plant) Alternative. All new development (expansion) of the approved Pilot Project (No Action) will be addressed and evaluated under each alternative in this EIS.



WRC SODIUM LEASE MAP

MAP 1-2

1.7 Authorizing Actions

As a result of this environmental analysis, a Record of Decision (ROD) will be issued. This ROD will contain the following:

—Decision(s) made
—Alternatives considered in the decision-making process
—Rationale for the decision
—Identification of mitigative measures that were added in the decision-making process
—Summarization of the enforcement and monitoring program(s) selected to carry out the decision.

The ROD will formally constitute approval, approval with modifications, or disapproval of Wolf Ridge Corporation's mine plan (Proposed Action) for a commercial nahcolite solution mine, pursuant to 43 CFR 3572.1. Any approval of a commercial-scale production alternative will contain a statement clearly specifying that, due to the nature of the technology to be employed, environmental impacts will be closely and carefully monitored. In compliance with the terms and conditions of the sodium leases and mitigation developed in this EIS, should this continuous monitoring indicate that significant impacts are occurring which were not anticipated in this EIS, the project will be shut down. BLM will then reassess the project, given the monitoring results, and determine whether additional mitigation will alleviate the impact or whether the project cannot be allowed to resume development.

Rights-of-way will be required for the off-lease portions of ancillary facilities covered under the approved mine plan pursuant to Title V of the Federal Land Policy and Management Act of 1976 (FLPMA), and Section 28 of the Mineral Leasing Act of 1920, as amended.

Many other federal, state, and local permits and approvals will be required prior to commencement of WRC's commercial-scale operations. They are listed as follows:

Permit/Approval	Agency
Regular Mining Permit	Colorado Mined Land Reclamation Division
Air Pollutant Emissions Notice	Colorado Air Pollution Control Division
Underground Injection Control (UIC) Permit	Environmental Protection Agency
Permits to Construct Wells	Colorado Division of Water Resources
Legal Identity Report	Mine Safety and Health Administration
Cultural Resource Clearance	Colorado State Historic Preservation Office

Pursuant to federal regulations 40 CFR Parts 144 to 147 (as promulgated from the Safe Drinking Water Act), the United States Environmental Protection Agency (EPA) has authority and responsibility to ensure protection of underground sources of drinking water (USDW) for activities involving the injection of fluids into the ground (i.e., the Proposed Action). This requirement will be administered by EPA through their Underground Injection Control (UIC) permitting process. Appendix F, "Analysis of the Proposed Action and the Underground Injection Control Program Administered by the Environmental Protection Agency," briefly explains the UIC program and the decisions confronting EPA regarding WRC's mine plan. This appendix is included as prepared and presented by EPA at their request and for their convenience.

2. PROPOSED ACTION AND ALTERNATIVES

2. PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

Pursuant to the National Environmental Policy Act of 1969 (NEPA) and the implementing regulations of the Council on Environmental Quality (CEQ), a range of four reasonable alternatives covering a full spectrum of possibilities are identified and analyzed in this environmental impact statement (EIS). These alternatives are:

1. The No Action Alternative
2. The Proposed Action
3. The 50,000 Ton Per Year (TPY) Alternative
4. The 500,000 TPY Alternative

Scoping did not identify any other alternatives considered for analysis in the EIS.

The alternatives described within this chapter represent a range of four possible development scenarios. Scale of project, based on yearly sodium production rate, is the primary difference between the alternatives. Alternatives considering different physical locations of the proposed project were not developed, primarily because of technological and geologic constraints associated with mining.

Since all of the alternatives involve the same solution mining process and basic development components, these elements are described in Section 2.2, "General Development Components." Section 2.3, "Description of the Alternatives," contains specific details and differences of each of the analyzed alternatives. This is followed by Section 2.4, "Mitigation," which describes the measures that would be applied to the approved action in an effort to alleviate or minimize potential environmental impacts. The baseline, which was developed in order to assess cumulative impacts, is described in Section 2.5. Tables 2-1 and 2-2, located at the end of this chapter, summarize the major differences and impacts by alternative.

It is important to remember that the No Action Alternative assumes construction and operation of a pilot-scale sodium mine by WRC. The pilot-scale mine plan was previously analyzed in an environmental assessment (EA Number CO-010-86-07) and subsequently approved on May 2, 1986, by BLM. As such, this action is independent of WRC's commercial-scale mine plan and can occur regardless of the outcome of this EIS.

The BLM's preferred alternative is the Proposed Action.

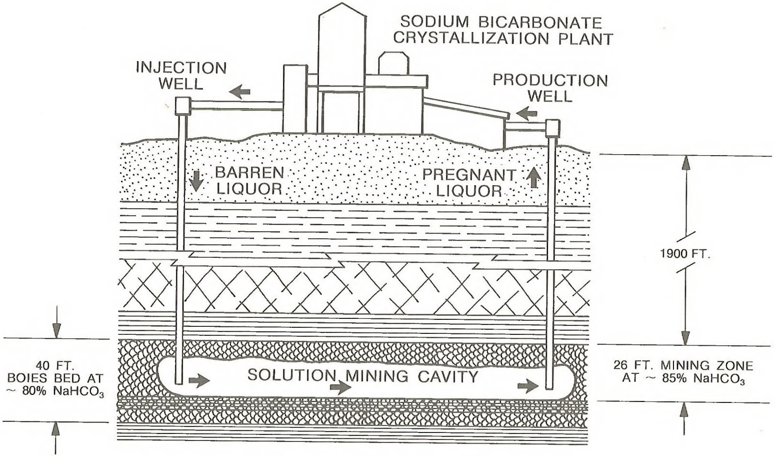
2.2 General Development Components

This section describes the various project components proposed by WRC that are common to all alternatives. This section does not describe the action as BLM would approve it (i.e., with BLM mitigation applied). The solution mining technique proposed by WRC, which is common to all four alternatives, involves drilling two wells, establishing communication between the wells by drilling two intersecting horizontal holes, and circulating hot water between wells to dissolve the nahcolite. Once the saturated solution is brought to the surface, the sodium bicarbonate will be recrystallized, dewatered, dried, and shipped to market. Figure 2-1 shows a general solution mining scenario.

The following subsections more specifically describe the various project components, as proposed by WRC, common to all alternatives. In addition, mitigative measures proposed by WRC are incorporated within these subsections. It is important to note that some of the described components and mitigative measures will change or be refined when BLM's proposed mitigation in Section 2.4 is applied to the approved action.

2.2.1 Production Zone and Product

The sodium minerals that would be solution mined are located in what geologists term the Boies Bed, a 40-foot thick sequence of nahcolite, oil shale, and nahcolitic-halite that assays between 80 and 85 percent sodium bicarbonate and lies at a depth of about 1,900 feet. Approximately 26 feet of this zone would be solution mined to produce various grades of sodium bicarbonate. Sodium bicarbonate has applications in solution buffering, textiles, plastics and rubber, soaps and detergents, fire extinguishers, leather manufacturing, medication, food stuffs, feed supplements, air pollution control, and sewer and water treatment. The recovery of in-place nahcolite within the Boies Bed would probably be about 40 percent. Approximately 12,000 tons of nahcolite would be produced from each cavity, assuming 300-foot well spacing.


SODIUM BICARBONATE CRYSTALLIZATION PLANT
INJECTION WELL
PRODUCTION WELL
BARREN LIQUOR
PREGNANT LIQUOR
1900 FT.
40 FT. BOIES BED AT ~ 80% $NaHCO_3$
SOLUTION MINING CAVITY
26 FT. MINING ZONE AT ~ 85% $NaHCO_3$

General Solution Mining Diagram
FIGURE 2-1

2.2.2 Drilling, Completion, and Abandonment of Production Wells

Each cavity would involve the drilling of two production wells 300 to 600 feet apart, and well spacing between the cavities would be 72 feet. Each well would initially be drilled with an auger or bucket type drill rig to a depth of 50 feet, with a hole diameter of 15 3/4 inches. A 13 3/8-inch surface casing would be cemented in place. The surface casing would be set so that it is no more than 1/2 degree off vertical. A mobile rotary drill rig positioned over the surface casing would then be utilized to drill a 12 1/4-inch hole to a depth of approximately 1,900 feet and circulated clean.

Deviation surveys would be periodically conducted during drilling to ensure that the hole did not exceed 1/2 to 1 degree drift from the vertical. High strength carbon alloy steel 8 5/8-inch casing would be placed in each hole, with approximately eight centralizers and a drillable float shoe at the bottom. The outside annulus (the space between the outside 8 5/8-inch casing and drill hole rock) would be filled with a high sulfate-resistant cement from the bottom of the hole up approximately 100 feet. From the top of this 100-foot cemented zone to surface, the annular space would be filled with a chemical gel-type mud (9 pounds per gallon or greater weight). The 8 5/8-inch casing would not be seated in the 13 3/8-inch surface casing.

Frac tanks would be used to store water at the drill pads for use during drilling. All drill cuttings would be placed in small 30 x 30 feet mud pits located near each well. Mud pits would be lined with bentonite to ensure containment of drilling fluids. Each pit would be used for one to two wells and would be reclaimed after drilling.

Well drilling activities would be concentrated during the late spring to early fall months.

Following completion of each well, horizontal drilling would be initiated from the bottom of each hole for a length approximately half the production well spacing; the goal would be to intersect about midway between wells. Once communication had been established between a pair of production wells, a 5 1/2-inch production string would be placed inside the outer casing of each well using centralizers. This casing string would not be cemented in the hole, but seated in the 8 5/8-inch casing. The 8 5/8-inch casing would then support the 5 1/2-inch casing at the top of the well head. The well head and pack off would be placed on top of each well with injection/extraction lines and pressure lines connected to the well head assembly.

Well abandonment would involve placing a cast iron bridge plug just above the casing shoe (approximately 1,900 feet). The casing would then be cut at approximately 1,800 feet and removed from the hole. Approximately 100-150 feet of cement would be placed on top of the cast iron bridge plug. The top of the cement plug would then be tagged and a column of hole abandonment plugging gel would be set from the top of the cement to within 65 feet of the surface. A 65-foot cement plug would then be set to surface. A surface hole location marker would be installed.

2.2.3 Solution Mining Process and Well Field Operation

The solution mining process involves utilizing a hot barren liquor (essentially hot water) to dissolve nahcolite within the Boies Bed. The hot barren liquor would be pumped from the process plant to the well field through an aboveground 8-inch diameter piping system. At the well field, the barren liquor would be diverted to a series of production well pairs through a 6-inch diameter aboveground piping system. Each well pair would consist of one injection well and one extraction well, each equipped with a nominal 5 1/2-inch diameter pipe string within the 8 5/8-inch well casing and extending from the well head down into the Boies Bed.

Barren liquor would be introduced into each mining cavity through the injection well with an injection pump. The injection pressure would force the flow of the barren liquor down into the Boies Bed, where the liquor would dissolve the nahcolite; the saturated pregnant liquor (containing dissolved nahcolite) would then flow out through the extraction well head through the plate and heat exchanger before entering an aboveground 6-inch piping system for transport to the process plant.

Each well pair would be equipped with an injection pump, a plate and frame-type heat exchanger and 6-inch insulated piping between the 8-inch header and the well head. The injection pump and heat exchangers would be skid mounted and the interconnecting 6-inch piping would be jointed in 20-foot lengths to facilitate handling during relocation to a new pair of production wells.

An auxiliary 6-inch pipeline would be incorporated into the system design that runs from the well field pipeline to a main plant sump. This would permit drainage of the well field pipeline to an evaporation pond when the pipeline has been relocated or repaired, or in the event of a pipeline rupture.

The well field pipeline system would be equipped with pressure sensing transducers tied to an alarm system to detect any failures in the system. In addition, the auxiliary 6-inch pipeline described above would be connected to all low points on the pipeline to permit draining of the pipeline to the process plant tankage or the evaporation pond. This pipeline and independent pumping system would be used to drain the pipeline before relocation or if a pipeline failed. All process pipelines would be installed aboveground to permit regular inspection of the condition of pipe joints and valves.

The remedial action to correct well failures would depend on the specific circumstances of the failure. If the failure were associated with the injection/extraction string, the 5 1/2-inch string pipe would be pulled and repaired, as appropriate. If the 8 5/8-inch outside casing failed, corrective actions would include spray coatings on the interior of the casing for small leaks, or in the event of major leaks or a break, a new well casing could be emplaced inside the old casing and cemented in place. The affected well would be tested for integrity and then placed back into operation following confirmation of the integrity test.

2.2.4 Plant Site Processing

Saturated solution (pregnant liquor) containing dissolved sodium bicarbonate would enter the process plant from the well field. Impurities, such as inorganic solids, would be removed from the pregnant liquor through filtering. The filtered solution would then flow to a crystallizer and then to a centrifuge. Next, the crystals would undergo drying; the product would then be sized and sent to the product bagging facility.

2.2.5 Evaporation Ponds

Evaporation ponds would be utilized to receive waste streams resulting from nahcolite solution mining operations. These ponds would be used to evaporate waste water from plant wash down, boiler blow down, water treatment system blow down, discharge from the filtering system, and well field pipeline drainage. The ponds would be 5 feet deep and would be built using a combination of excavation and berm construction. Interior berm slopes would be constructed at 1V (vertical) to 3H (horizontal), and exterior slopes would be constructed at 1V to 4H. The exterior slopes would be stabilized with vegetation to control erosion. An 8-foot high woven-wire fence would be installed around the ponds.

The ponds would be lined with a double impervious liner and an intermediate leakage collection/detection system consisting of a 20 mil PVC bottom liner covered with a 6-inch thick drain blanket and a 20 mil Hypalon cover liner. A 4-inch diameter PVC perforated drain pipe would be placed above the underliner in a trench along the pond centerline to collect and carry leakage, if it occurred, to a small holding tank where it could be collected and monitored.

The design evaporation rate used for the evaporation ponds is 1 gallon per minute (gpm) per acre annual average evaporation rate, which is based on the operating experience of Rio Blanco Oil Shale Company at nearby prototype Tract C-a. Size and number of ponds would be determined, based on anticipated inflow rates into ponds and would take into account appropriate safety factors. Solids would be periodically removed from evaporation ponds for disposal at an approved off-site disposal area.

2.2.6 Product Handling and Transport

Following drying and sizing, the product would be stored in storage silos. From the storage silos, the product would be sent to the product bagging facility where it would be bagged and shipped on pallets, via 26-ton capacity trucks, directly to customers or to a warehouse/rail loading facility at Lacy Station railhead west of Rifle. Bagged material would leave the warehouse via rail (boxcar) or truck to the various customers.

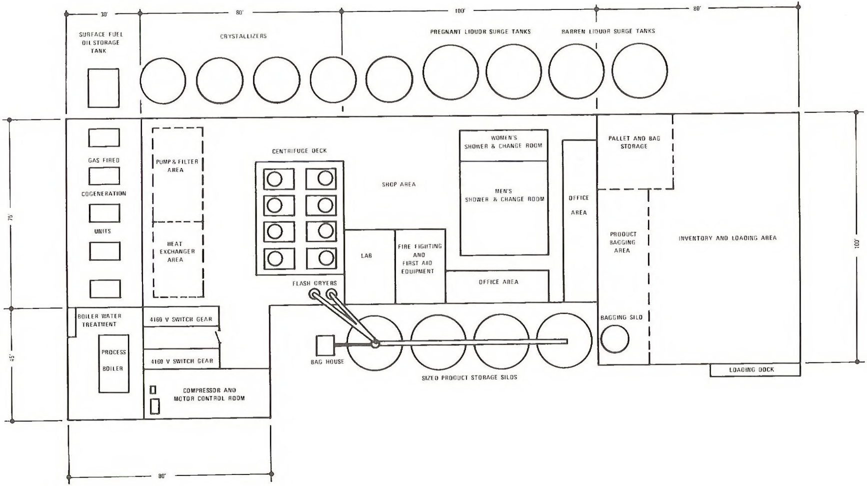
2.2.7 Plant Site Facilities

Surface facilities associated with a nahcolite solution mining project would include the following.

1. All weather, pre-engineered steel-type buildings would be used to house plant process equipment, lab and offices, process boiler, electrical power generation equipment, compressors, and product bagging facility. They would be erected over concrete slab and foundations that would meet Rio Blanco County building codes. Buildings would have concrete floors and a launder system to collect any spills within the plant and to receive water during plant wash down. The launder/sump system would gravity drain to an evaporation pond via a buried 12-inch diameter pipeline.
2. Conditioner tanks, barren and pregnant liquor surge tanks, product storage silos, fuel oil storage tanks, and water storage tanks would be located outside of and adjacent to the main process buildings. These tanks would be built over a bermed concrete or asphalt pad so that any spills would be contained, directed to the main plant sump, and pumped to the evaporation pond. Berms would be of sufficient height to contain the entire volume of the tanks. Figure 2-2 shows a typical plant site facilities layout of a commercial-scale project.

2.2.8 Operating Schedule

The operating schedule for the sodium solution mine would be 330 days per year (90 percent operating time), 7 days per week, and 24 hours per day. This schedule provides 35 days per year of scheduled downtime for equipment maintenance and repair.



Typical Commercial Scale Plant Site Facilities Layout Diagram
FIGURE 2-2

2.2.9 Utilities

Electrical power would be required to operate solution mining and processing plant facility equipment. Type of electrical generation would depend on the scale of operation (i.e., the alternative).

Water would be required for solution mining, processing, boiler feed, potable, and fire protection uses. Water would be supplied from a water well in Section 24, Township 1 South, Range 98 West. It would be pumped through a buried 4-inch diameter, 10,000-foot long water pipeline from the well to a water storage tank (75,000 gallon capacity) near the plant site. This water pipeline is shown in Map 2-1.

The sewage system would consist of a septic tank and seepage bed designed in accordance with state and county standards. The system would allow for 35 gallons of water per day per person. A 2,500-gallon capacity precast concrete septic tank would provide the minimum 30-hour retention time required before seepage. The seepage bed would consist of a series of distribution pipes emanating from a precast concrete distribution box. The pipes would be buried in a gravel layer with a minimum thickness of 12 inches and covered with an additional 12-inch layer of soil.

2.2.10 Access

An existing dirt road, approximately 3.3 miles in length, would be utilized to access the sodium mine facility. This road, as shown in Map 2-1, would be upgraded to accommodate access from existing paved Ryan Gulch Road (Rio Blanco County Road 24) to the plant site. The degree of upgrading would be dependent on number, type, and loads of vehicles associated with the operation. Drainage would be provided, as required, to control surface water runoff for a 100-year storm. Ditches would be "V" bottom or flat bottom, with a minimum depth of 18 inches and, where necessary, energy absorbers would be constructed to regulate flow velocities and prevent excessive erosion. Culvert pipe would be corrugated steel pipe conforming to AASHTO M36-74 and bedded and backfilled with sand or gravel compacted to 95 percent of maximum density (ASTM-1557). Rock riprap would be installed at the culvert outfalls to dissipate energy and prevent erosion. After road upgrading, the slopes of cut and fill sections would be contoured, covered with topsoil, seeded, and mulched.

2.2.11 Reclamation

Reclamation of the disturbed area would be consistent with its current use as rangeland and wildlife habitat. Disturbed areas would be restored to a condition equal to or better than their original condition. Areas that are disturbed during project construction would be reclaimed as soon as practicable to minimize erosion or other detrimental environmental effects.

Before construction or any mining activities, vegetation would be cleared and soil would be grubbed to a depth of 1 foot. Topsoil would be removed from the area to be disturbed and stockpiled. Surfaces of topsoil stockpiles would be stabilized and protected from wind and water erosion by seeding with rapidly establishable grass and forb species. In cases where seeding attempts failed or when topsoil could not be stabilized by seeding, stockpiles would be stabilized by application of a chemical dust suppressant.

Where feasible, topsoil would be removed from areas that were being stripped and directly applied to well sites or other disturbed areas, rather than stockpiled. Limitations that would influence the use of this technique include the haul distance and reclamation sequences.

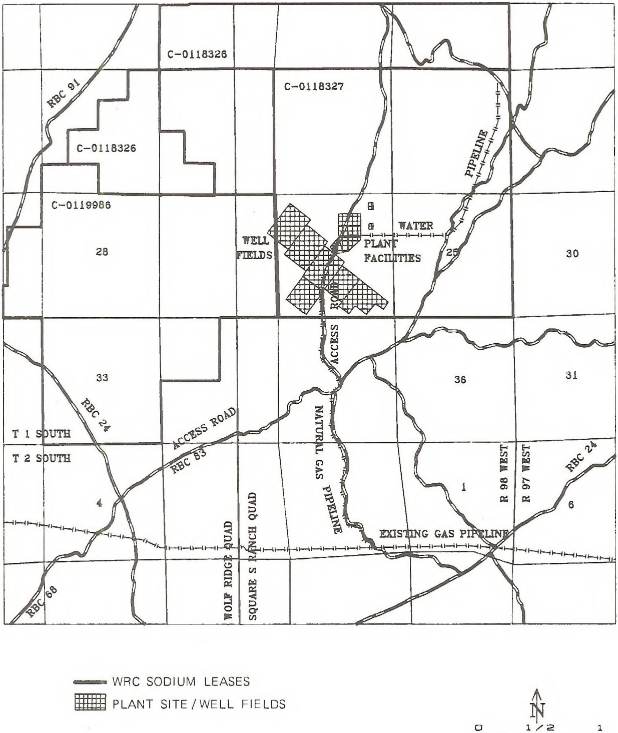
All disturbed areas would be graded to slopes consistent with the surrounding area. Grading would also be done to control erosion and siltation of the affected and unaffected lands. Measures such as contour furrowing, installing water bars, etc., would be used where necessary to ensure that soil erosion was kept to a minimum. Surface drainage patterns would be reestablished to premining conditions.

In situations where surface disturbance would be necessary on slopes greater than 3:1, special precautions would be taken to minimize erosion, both during and after operation of these portions of the well field. Water bars and ditches would be used during operation to minimize potential adverse impacts from erosion. Reclamation of these areas would incorporate water bars and contour furrowing to aid in erosion control.

Where necessary, heavily compacted surfaces would be ripped before receiving a topsoil cover. Surface tillage and seedbed preparation would consist of light or shallow tillage operations, using a combination of disk harrow and spike-tooth harrow. The final tillage treatment would be performed by a shallow chisel plow on level contour or by a lister or rangeland pitter, where necessary, depending on soil conditions.

The reclamation seed mixture would be placed by either a drill seeder or by broadcast seeding, depending on the slope. The use of a drill seeder requires slopes of less than 3:1 (33 percent). Drill rows would be 20 to 25 centimeters apart. If the seed were broadcast, the amount of seed would be doubled. Seeding would be followed with a packer or roller.

Following seeding, straw or native pasture hay would be used as a mulch, approximately 2 tons per acre. The mulch would be mechanically crimped. Any prohibited noxious weeds that might appear in reclaimed areas would be controlled, as necessary, by chemical and/or mechanical means.



PROPOSED ACTION ALTERNATIVE (125,000 TPY)

MAP 2-1

Disturbed areas associated with construction of the access road, pipelines, plant site, and evaporation ponds would be recontoured and reclaimed the first fall after construction.

Disturbed areas associated with the well field would be reclaimed and revegetated as soon as practical after the cavities had been mined out. Interim erosion control measures to be used until these areas have been reclaimed would include seeding topsoil storage piles, diverting precipitation runoff away from disturbed areas, use of water bars to minimize erosion from disturbed areas, and use of ditches to intercept precipitation runoff from disturbed areas.

At completion of sodium mining operations, all surface facilities would be dismantled. Concrete foundations and road pavements would be broken up and buried on-site, at least 3 feet below grade. Salts remaining in the evaporation ponds would be removed and disposed of either in a mined-out cavity or at an approved off-site landfill. Pond liners would be removed and disposed of at an approved off-site landfill. The natural gas and water pipelines would be disconnected and purged; however, they would be left in place because these areas would have already been reclaimed.

All disturbed areas would be reclaimed according to the above plans.

2.2.12 Monitoring

Various types of monitoring would be instituted in an effort to verify projected environmental effects of solution mining operations and reclamation success on disturbed lands.

2.2.12.1 Groundwater Monitoring

Former production wells would be utilized as monitoring wells. Once a series of production wells were completed, former down-gradient wells would be used as monitoring wells completed in the lower aquifer. As the injection/extraction process moved to the up-gradient wells, the spent production wells would be converted to monitor wells, with the lower aquifer sealed off from the mining cavity, and new production wells would be completed up gradient. Continuous monitoring of piezometric head and collection of water quality samples on a monthly basis would be conducted at the lower aquifer. The number of monitoring wells would be dependent on the number of cavities in operation at a given time.

The water quality analyses would be performed by a state-approved laboratory. The results would be submitted to the Environmental Protection Agency (EPA) on an annual basis and would summarize the results of the monitoring program.

2.2.12.2 Mechanical Integrity Monitoring of Wells

A monitoring program would be implemented to assure the mechanical integrity of the injection and extraction wells. The space between the outside of the 5 1/2-inch production pipe string and the interior of the 8 5/8-inch well casing would contain air compressed to 800 pounds per square inch gauge (psig) to prevent any mining fluids from occupying the interior of the casing and to ensure casing integrity. Air pressure in the 8 5/8-inch casing would be continuously monitored, and an alarm would sound when pressures dropped below 700 psig. If the air pressure could not be increased back to 800 psig and maintained for a reasonable length of time, a casing failure might have occurred. In this event, the well would be taken out of service and corrective procedures would be initiated. Corrective measures might include spray coating the interior of the casing if a small leak were indicated or installing an inner sleeve casing within the original casing if more substantial leaks were indicated. In addition to the air pressure monitoring, metering of daily injected and produced fluid volumes would be recorded. This system would allow one to inventory fluids in and out of the production wells.

Reporting of the results of the mechanical integrity monitoring program would occur on a quarterly basis. The report would be submitted 60 days after the end of each quarter and would include the results of air pressure monitoring and the manifold monitoring program.

The quarterly periods and reporting dates would be as follows:

January-March	May 31
April-June	August 31
July-September	November 30
October-December	February 28

2.2.12.3 Subsidence Monitoring

Multiple point borehole extensometers (MPBX) would be installed concurrent with well field development at 100 to 200-foot depth intervals from a depth of 1,800 feet to 1,300 feet below grade to measure deflections resulting from subsidence. In addition, the potential surface expression of subsidence would be monitored by setting and surveying surface monument elevations with respect to a reference point that would remain unaffected by subsidence. One MPBX borehole would be installed for every 12 cavities up to a maximum of 7 MPBX boreholes. The installation and monitoring of surface monuments would continue for the duration of mining on a twice-per-year basis.

2.2.12.4 Reclamation Monitoring

A reclamation-oriented monitoring program would be implemented to evaluate the success of any reclamation and provide rapid recognition of any problem areas.

If reclamation or soil stabilization were unsuccessful, potential causes for the failure would be evaluated. The soils might be tested for toxic, sodic, pH, or other conditions that might prohibit successful revegetation. Depending on the results of this testing, the soils might be removed, covered with more suitable material, or amended to provide a more favorable growth medium.

Generally, vegetative transects would be sampled each year during the growing season. The reclamation program would be implemented by qualified personnel with both practical field experience and a knowledge of reclamation practices.

Other parameters such as ambient air quality and meteorology would be monitored if required by the Colorado Air Pollution Control Division.

2.2.13 Other Applicant Proposed Mitigation

The following is a list of other proposed mitigative measures extracted from WRC's Proposed Action mine plan that are not incorporated within the previous narrative. These measures are considered committed, not only for the Proposed Action, but also for the other two commercial-scale project alternatives (i.e., 50,000 TPY and 500,000 TPY alternatives), unless otherwise noted.

1. Restrict traffic to existing roads to minimize possible wildlife habitat destruction.
2. Follow state and federal rules and regulations, as well as permit requirements and stipulations, to prevent and minimize damage to wildlife.
3. Restrict hunting on the property to increase human safety and reduce wildlife harassment and impacts.
4. Restrict on lease vehicle traffic to established roads; establish speed controls to reduce wildlife road kills.
5. Educate workers about potential wildlife impacts, permit requirements to protect wildlife, and impose necessary control measures to minimize wildlife impacts.
6. Encourage car pooling to reduce the potential for road kills of wildlife.
7. Build fences around the project area that will not impede wildlife migration but will prevent livestock from entering the project area.
8. Build fences to prevent access by wildlife and livestock where consumption of contaminated water would be detrimental.
9. Implement a monitoring program to determine the effects and impacts the project has upon mule deer after some reclamation of the well field has been completed.
10. Before removing, examine trees individually for evidences of raptor nesting (especially important during spring nesting period).
11. Construct all powerlines in accordance with standards established in the USDA REA Bulletin 61-10.
12. Level the plant site area and gravel parking areas under the 50,000 TPY Alternative and pave parking areas under the Proposed Action and 500,000 TPY Alternative.
13. Make rib pillars between individual mine cavities 20 feet thick, as measured at the top of the pillar.
14. Collect all trash and garbage generated by plant operations in covered containers for subsequent off-site disposal at an approved landfill.
15. Apply fabric filtration and a cyclone separator to control emissions from product handling. Use water sprays with a chemical dust suppressant to control fugitive dust. Apply catalytic convertors to control NO_X emissions from the generators.

2.3 Description of the Alternatives

This section contains specific descriptions of each of the four alternatives analyzed in this document. Changes from the general development components and between alternatives that result from project scale (i.e., yearly production rate) are described under each alternative.

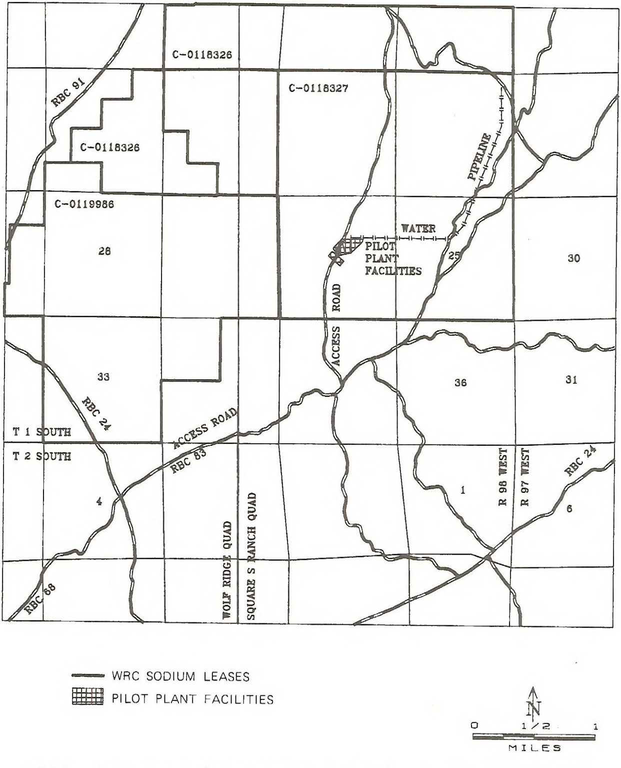
2.3.1 No Action Alternative

Consideration of the No Action Alternative is required in accordance with regulations issued by the Council on Environmental Quality (1978) and under the provisions of the National Environmental Policy Act of 1969. Under the No Action Alternative, the approved pilot-scale sodium project will take place; however, expansion of the approved pilot-scale sodium project (Phase II) to a commercial-scale sodium mine (Phase III) will not occur.

The approved pilot-scale project involves construction and operation of a 6-ton per hour (maximum 36,000 tpy) sodium mine for a maximum of 2 years. Map 2-2 shows the location of the pilot project and ancillary facilities. Further detail is shown on Map 2-3. Specific details of this project are described in the following subsections.

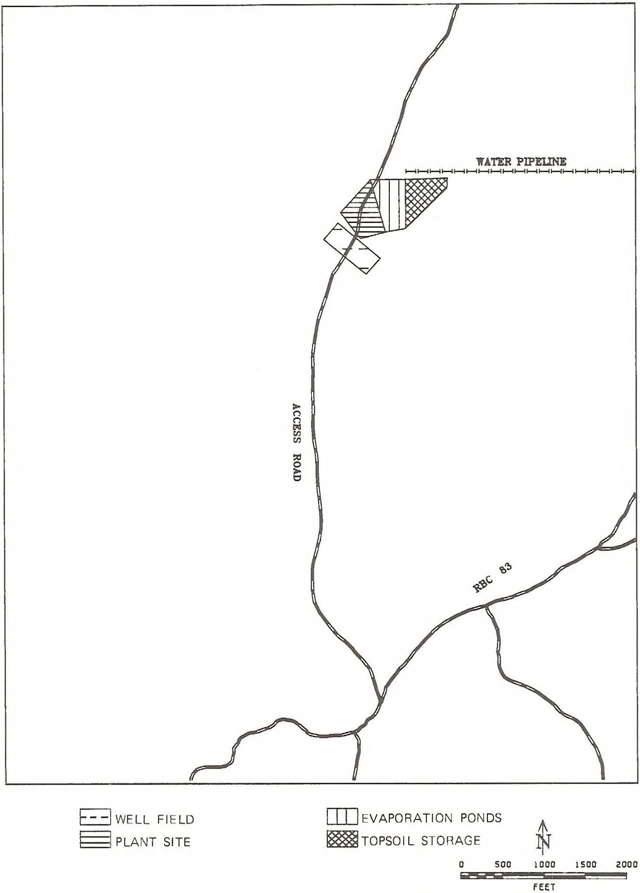
2.3.1.1 Plant Site Facilities

Approximately 5 acres will be utilized in construction and placement of sodium processing and handling facilities. Facilities will include a 58- by 96-foot recrystallization



NO ACTION (PILOT PLANT) ALTERNATIVE

MAP 2-2



NO ACTION(PILOT PLANT) ALTERNATIVE

MAP 2-3

building, and a 24- by 45-foot high nahcolite storage/load-out bin. In addition, an 8- by 26-foot trailer will be utilizedfor a shower and locker facility, and a 12- by 66-foot trailer will be utilized as an office facility.

2.3.1.2 Well Field Operations

A maximum of three mine cavities involving six production wells will be utilized for solution mining of nahcolite. No well head heat exchanger will be utilized in the well field. Instead, when the first cavity is mined out, the main pipe headers will be extended and the secondary piping will be disassembled and relocated above the second cavity. Before moving the pipes, all fluids will be drained to the evaporation pond. Approximately 4 acres will be involved with development of the well field.

2.3.1.3 Evaporation Ponds

One evaporation pond will be required for operation of the pilot-scale solution mine. Construction of this pond will disturb approximately 4 acres of land. This pond will provide 2 acres of evaporation surface for disposal of plant waste water. Flow to the evaporation pond will be 2 gpm, with a total pond volume (with 1 foot of free board) of 4,542,000 gallons.

2.3.1.4 Product Handling and Transport

All produced material will be bagged on site and hauled by truck either directly to customers or to a storage area in Rifle. No product will be stored at the mine site. Product haulage trucks will make six round trips per day, 5 days per week, between the plant site and the Rifle storage area.

2.3.1.5 Utilities

Electrical power will be provided by two 850 kw diesel-fueled generators (one operating and one standby). Process heat will be supplied by two 250-horsepower diesel-fueled boilers.

Approximately 60 gpm (88 acre-ft/year) of water will be required for the pilot project. A frac tank located on the plant site will be utilized for water storage under this alternative.

2.3.1.6 Access

The 3.3-mile long existing dirt access road will be upgraded and maintained to meet or exceed Rio Blanco County Class D-Mountainous road standards as follows:

Road Width: Two 11-foot wide traffic lanes
Two 7-foot wide shoulders
Total Width: 36 feet
Gravel: 8-inch thick base coarse of 3-inch gravel or pit run
4-inch thick coarse of 3/4-inch gravel
Total Gravel: 12 inches

Grade: Less than 8 percent

Curves: 24 degrees maximum

Pursuant to Title V of the Federal Land Policy and Management Act of 1976, the operator has obtained a right-of-way grant, serial number C-37773, authorizing such upgrading and use of the off-lease portion of the access road on public lands from existing paved Ryan Gulch Road (Rio Blanco County Road 24).

Vehicular traffic to and from the plant site, 5 days per week, is estimated as follows:

26-ton capacity haul trucks—6 round trips per day
Light duty trucks and autos—12 round trips per day
Supply trucks—1 round trip per day

The bulk of this traffic is estimated to travel between Rifle and the project site.

2.3.1.7 Committed Mitigation

The following mitigative measures (stipulations) were applied by BLM to the approved Pilot-Scale Project Mine Plan in an effort to minimize potential environmental impacts; therefore, these measures are committed and are part of the No Action Alternative (Pilot Project).

2.3.1.7.1 General

If additional construction material is necessary for development associated with the pilot plant or ancillary facilities (i.e., access road, water pipeline), the designated operator/lessee shall submit an application to the Authorized Officer for authorization to obtain such material if located on public lands.

The designated operator/lessee shall locate, handle, and store gas, oil lubricants, and other petroleum products in such a manner so as to prevent them from entering into and contaminating water resources and soils on the public lands.

The United States of America considers the development of groundwater resources to be necessary and frequently indispensable to effective land management. The United States shall have the first opportunity to file a state water right for any intercepted groundwater. The designated operator/lessee may file for water rights within the lease, only with a written waiver from the District Manager. The Bureau of Land Management concedes the existence of any water right that the Wolf Ridge Corporation and its affiliates may own or control prior to the date of approval of this mine plan.

The Authorized Officer shall be contacted at least 24 hours prior to:

1. Surface disturbing construction or maintenance activity
2. Commencement of reclamation activity
3. Commencement of drilling and logging operations

2.3.1.7.2 Evaporation Pond

The designated operator/lessee will be required to pump and haul waste water from the evaporation pond to an approved disposal site if the evaporation pond reaches or exceeds its design capacity, unless otherwise approved in writing by the Authorized Officer.

The liners of the evaporation pond will be underlain by a minimum of 4 inches of suitable soil material containing at least 95 percent material passing the No. 10 sieve (ASTM E-11 specifications) or other approved method.

A water-tight catchment basin or other approved method will be employed at the outlet of the leak detection system on the evaporation pond to contain any leaked fluids.

A buffer zone of 15 feet of undisturbed vegetation will be maintained between the toe of the fill slope on the east side of the evaporation pond and the edge of the adjacent major drainage.

2.3.1.7.3 Well Drilling, Completion and Abandonment

A temperature survey log shall be run, from the top of the cement behind the 8 5/8-inch well casing to the surface, within 14 days before abandoning any well bore and before pulling any 8 5/8-inch well casing.

A "Notice of Intent to Abandon" will be submitted by the designated operator/lessee to the Authorized Officer prior to abandonment of any well developed within this project. The notice will contain an "as-built" diagram of the well and will describe any changes from the approved abandonment/plugging procedures. The Authorized Officer will review and approve or approve with modifications the notice within 15 calendar days of receipt. No special form for this notice is required. As a minimum, the following plugs will be required: 1) a steel bridge plug will be placed at the base of the production casing; 2) 50 feet of cement will be placed above this plug; 3) a cement plug will be placed 50 feet below the Mahogany Zone through to 50 feet above the production casing stub; and 4) 65 feet of cement will be placed at the surface. The intervals between the cement plugs will be filled with 9 pound/gallon or heavier drilling mud. Other cement plugs may be required, based on analysis of the cement bond logs and the temperature survey log.

Diverter lines for the blow out preventer shall be directed into a lined mud pit at least 125 feet from the well.

Adequate waiting-on-cement times shall be observed for all cementing operations to achieve a minimum of 500 psi compressive strength.

The annulus between the well bore and the 8 5/8-inch well casing will be filled with cement from the bottom of the hole to the top of the A-Groove.

Drilling fluid material will be contained in bentonite lined mud pits and hauled to the evaporation pond upon completion of drill holes, unless otherwise approved in writing by the Authorized Officer.

2.3.1.7.4 Monitoring

Daily monitoring of the mud gel in the annulus between the 13 3/8-inch surface casing and 8 5/8-inch well casing will be required, and any observed changes and/or any remedial measures taken shall be reported monthly to the Authorized Officer.

The groundwater zone 50 feet above the dissolution surface will be monitored. The monitoring well shall be equipped with a continuous graphic water-level recorder. The well shall be sampled two times, 1 week apart, for major and trace constituents, as soon as completed and cleaned out properly and then sampled for major constituents at least once a month during solution mining. Monthly sampling shall continue for a period of up to 3 years (at the discretion of the Authorized Officer) after the mining has been completed, at which time trace elements shall again be sampled. Any effects on the monitored zone detected during operations shall be reported to the Authorized Officer and sampling frequency increased to at least once a week.

Unless otherwise authorized by the Authorized Officer, the well shall be sampled for the following:

Field Measurements (Monthly)

temperature
pH
conductivity

Lab Analyses - Major Components (Monthly)

total dissolved solids

alkalinity
sodium
bicarbonate
carbonate

Trace Components

(Sample initially and if lower aquifer is affected)

arsenic
manganese
chromium
beryllium
molybdenum
zinc
lithium
sulfide
potassium
boron
chloride
aluminum
selenium
nickel
copper
bismuth
mercury
nitrate
magnesium
total phosphate
silica
dissolved organic carbon
cadmium
barium
vanadium
strontium
lead
bromide
calcium
fluoride
sulphate
iron

Lab analysis work must be performed by a laboratory approved by the Authorized Officer.

Discharge of water will not be allowed without prior written approval from the Authorized Officer of the BLM.

Subsurface subsidence of the solution cavities will be monitored. The monitoring system will be designed by the designated operator/lessee and will include a method for verifying cavity configuration. This design will be submitted to the Authorized Officer for approval. The Authorized Officer will approve, or approve with modifications, the design within 30 days of receipt. The monitoring system will be in operation before sodium production and will continue for at least 3 years, or longer if conditions warrant, as determined by the Authorized Officer.

2.3.1.7.5 Submittals

The following information shall be submitted to the Authorized Officer within 30 days after it has been obtained:

1. One copy of all hydrologic data obtained from drilling and monitoring.
2. Copies of all downhole logs, including temperature logs.
3. Fluid injection and production volumes and corresponding pressures.
4. The daily 5 1/2-inch by 8 5/8-inch annular pressure readings.
5. Copies of the mud check sheets.
6. Daily monitoring data of the 13 3/8-inch by 8 5/8-inch annulus.

The cement bond logs shall be submitted to the Authorized Officer within 10 days after logging.

Specific details and specifications for epoxy spray coatings of minor casing leaks will be provided to the Authorized Officer before initiating well construction.

The Authorized Officer will be notified of all spills, leaks and pressure losses within 24 hours of the occurrence during the week, or first thing Monday morning if the occurrence is on a weekend.

2.3.1.7.6 Reclamation

Interim reclamation measures may be necessary before the end of the project, as determined by the Authorized Officer. In addition, erosion control measures may be necessary, as directed by the Authorized Officer.

Topsoil will be stripped to appropriate depths (about 6 inches for the Rentsac and 20 inches for the Yamac soils) on all areas that will be disturbed by pilot plant development and will be stockpiled for future restoration as directed by the Authorized Officer. Topsoil stockpiles will be fenced with single strand wire and will be appropriately shaped, i.e., slopes 4:1 or less, to minimize erosion before seeding and to maximize establishment of vegetation. Stockpiles will be adequately designated with signs. Topsoil shall not be used as pipeline padding or be mixed with spoils.

Whenever possible, salvaged topsoil will be applied directly to recontoured areas, reducing, to the greatest extent possible, long-term topsoil stockpiling.

Topsoil stockpiles and exterior cut and fill slopes of the evaporation pond will be seeded, as soon as possible, with the following interim reclamation seed mix to enhance viability of stockpiled topsoil and to minimize potential erosion problems with both stockpiles and the evaporation pond:

Species	**Variety**	**Pounds Pure Live Seed/Acre**
Grasses		
Pubescent wheatgrass	Luna	4
Thickspike wheatgrass	Critana	2
Forb		
Alfalfa	Ladak *	2

* preinoculated

Wherever possible, at least 12 inches of topsoil will be reapplied to disturbed areas after recontouring. When topsoil availability precludes a 12-inch application rate, as much topsoil as is available will be applied, but in no case will reapplied topsoil depth be less than 6 inches.

Reclamation will be initiated as soon after disturbance as possible, or as directed by the Authorized Officer.

Surface disturbing activities shall not be performed during periods when the soil is too wet to adequately support equipment. If equipment creates ruts in excess of 3 inches deep, the soil shall be deemed too wet to adequately support equipment. Mud blading is not considered an alternative to meeting the criterion in this stipulation.

The designated operator/lessee will be responsible for monitoring reclaimed areas for at least three complete growing seasons after final reclamation work has been completed. Monitoring will continue to be required until reclamation goals have been successfully achieved and reclamation qualifies for bond release. Monitoring methods will be subject to the approval of the Authorized Officer and the following elements (at a minimum) will be quantified:

1. Vegetative production
2. Crown cover
3. Plant composition

Reclamation will be considered for approval and bond release only after the results of monitoring have been presented to BLM. Reclamation will be considered a failure and remedial measures will be required before bond release if one or more of the following conditions persist:

Reclamation will be considered for approval and bond release only after the results of monitoring have been presented to BLM. Reclamation will be considered a failure

and remedial measures will be required before bond release if one or more of the following conditions persist:

1. Production of herbaceous perennial species by category (forb, grass) is less than that measured on representative undisturbed areas.
2. Shrubs comprise less than 12 percent and perennial forbs less than 4 percent of the established plant composition by cover.
3. Perennial crown cover is less than that measured on representative undisturbed areas.
4. Soil erosion rates on reclaimed areas exceed that of representative undisturbed areas.

All merchantable forest products within the project development area that are taken, damaged, or destroyed will be purchased by the designated operator/lessee at the total appraisal price, which will be determined by the Authorized Officer, Bureau of Land Management (BLM), White River Resource Area. Disposal will be as follows:

All stems, stumps and branches over 4 inches in diameter shall be: a) removed from federal land for resale or private use, or b) cut into lengths not exceeding 4 feet and scattered away from the disturbance. All stems and branches less than 4 inches in diameter shall be evenly scattered away from the disturbed area.

Annual or noxious weeds shall be controlled on all disturbed areas, as directed by the Authorized Officer. The method of control shall be by an approved mechanical method or an EPA registered herbicide. All herbicide application proposals must be under direct field supervision of an EPA certified pesticide applicator.

The species mixture submitted in the mine plan for use in reclamation is amended as follows:

Species	**Variety**	**Pounds Pure Live Seed/Acre**
Grasses		
Thickspike wheatgrass	Critana	0.50
Streambank wheatgrass	Sodar	0.50
Western wheatgrass	Arriba	1.00
Pubescent wheatgrass	Luna	0.50
Basin wildrye	Magnar	0.50
Russian wildrye	Vinall	0.50
Green needlegrass	Common	2.00
Orchardgrass	Paiute	0.25
Forbs		
Lewis flax	Apar	0.20
Cicer milkvetch	Monarch *	0.50
Alfalfa	50% Ladak *	0.75
	50% Nomad *	0.75
Small burnet	Delar	1.00
Shrubs		
Fourwing saltbush	Rincon (dewinged)	1.50
Winterfat		0.50
Antelope bitterbrush		1.00

* preinoculated

The quantity of seed applied on-the-ground will be determined on a Pure Live Seed (PLS) basis, PLS being defined as "tested purity rate" x "tested rate of germination." For example, the quantity of western wheatgrass seed (95 percent purity, 70 percent germination) needed to meet a stipulated 1.0 pound PLS/acre application rate:

Actual applied seed rate = required PLS rate (lb per acre) ÷ PLS index = 1.0 lb per acre ÷ 019 x 0.07 = 1.5 lb per acre

Site-adapted, tested seed for the current year is required and is subject to the approval of the Authorized Officer (copies of the seed labels will be furnished to the Authorized Officer).

Specific cultural practices that promote the establishment and survival of seeded forbs and shrubs will be employed where practicable, subject to the approval of the Authorized Officer.

On-site burial of the concrete or asphalt pad at the time of pilot plant site decommissioning is subject to prior approval of the Authorized Officer.

The designated operator/lessee shall promptly remove and dispose of all waste to an approved landfill, as directed by the Authorized Officer. The term "waste" as used herein means all discarded matter including, but not limited to, human waste, trash, garbage, refuse, petroleum products, ashes, and equipment.

Drainages shall not be blocked with loose dirt or debris.

Before termination of the authorized facilities, the designated operator/lessee shall contact the Authorized Officer to arrange a joint inspection of the facilities and the disturbance. The inspection will be held to determine if any reasonable and necessary changes, revisions, or additions need to be made to the approved restoration and rehabilitation plan.

Upon completion of recontouring and reseeding operations on the pilot plant site and well field, the entire reclaimed area will be fenced off with four strand barbed wire fence with braced corner posts conforming to BLM Type D fence specifications (Appendix A). Reclaimed areas shall remain fenced to effectively exclude livestock use for a minimum of three complete growing seasons following final reclamation work and until bond release is approved by the Authorized Officer.

2.3.1.7.7 *Range and Wildlife*

Where the access road crosses the pasture fence in Section 35, Township 1 South, Range 98 West, the designated operator/lessee will install a cattle guard of sufficient width to conform with planned road upgrading. A 16-foot gate will be installed adjacent to the cattle guard. Construction will be according to the BLM specifications in Appendix A.

All powerlines and electric transmission facilities (aboveground) will conform to accepted raptor protection design criteria as presented in: Suggested Practices for Raptor Protection on Powerlines — State of the Art in 1981, Raptor Research Report No. 4, Raptor Research Foundation, Inc., c/o Dept. Veterinary Biology, University of Minnesota. St. Paul, Minnesota 55101.

Upon completion of BLM's Section 7 Consultation requirements with the U.S. Fish and Wildlife Service, any threatened and endangered species conservation measures developed through the Section 7 Consultation process will be imposed on the applicant, either directly by the U.S. Fish and Wildlife Service, or through approved Environmental Assessment CO-017-86-07 (BLM 1986), as additional required mitigation.

In the event any raptor nest site is encountered during facility siting or well field construction, the designated operator/lessee shall notify the Authorized Officer immediately. Appropriate mitigative measures will be formulated at this time by the White River Resource Area Manager, if necessary.

Where the Authorized Officer determines that consumption of contaminated water will be detrimental to animals, the designated operator/lessee shall prevent access by appropriate fencing with 8-foot high woven wire or chain link fence. The evaporation pond shall be fenced as such.

Preparative or construction activity associated with the water pipeline shall not be allowed from December 1 to March 31 in order to prevent undue harassment of deer on affected severe winter range. This restriction is conditional; the White River Resource Area Manager may rescind the order if prevailing winter conditions fail to pose unusually severe constraints on mule deer winter maintenance.

2.3.1.7.8 *Archaeology/Paleontology*

If in its operations, the designated operator/lessee discovers any cultural remains, monuments or sites, or any object of antiquity subject to the Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C. Sec., 431-433), the Archaeological Resources Protection Act of 1979 (Public Law 96-95), and 43 CFR, Part 3, the designated operator/lessee shall immediately cease activity and report directly to the White River Area Manager. BLM will then take necessary action to comply with the above legislation. The designated operator/lessee shall follow the mitigative requirements set forth by BLM concerning protection, preservation, or disposition of any sites or material discovered. All known and identified sites will be avoided by project design. If this is not prudent and feasible, consultation with the State Historic Preservation Officer (SHPO), as specified in 36 CFR 800, will be required. In cases where mitigation is necessary, the cost of such mitigation shall be borne by the designated operator/lessee, unless otherwise agreed on.

The designated operator/lessee shall not knowingly disturb, alter, destroy, or take any fossils of significant scientific interest, and shall protect all such fossils in conformance with the measures included in the approval of the mining plan.

The designated operator/lessee shall immediately report any such fossils that might be altered or destroyed by the operation to the attention of the District Manager. Operations may continue as long as the fossil specimen or specimens will not be seriously damaged or destroyed by the activity. The District Manager shall evaluate or have evaluated such discoveries brought to his attention and, within five working days, shall notify the designated operator/lessee what action shall be taken with respect to such discoveries. All such fossils of significant scientific interest shall remain under the jurisdiction of the United States until ownership is determined under applicable law. Copies of all paleontological resource data generated as a result of the lease operations will be provided to the District Manager. The cost of any required salvage of such fossils shall be borne by the designated operator/lessee. These conditions apply to all such fossils of significant scientific interest discovered within the lease area.

No road work is to be initiated in Section 34, Township 1 South, Range 98 West, and Section 3, Township 2 South, Range 98 West, until completion of the Section 106 consultation process on sites 5RB390 and 5RB400 has been completed.

2.3.1.7.9 *Roads and Pipelines*

Periodic watering of the access road, well field road, and plant site will be carried out to control fugitive dust emissions. This stipulation will apply particularly from May through October. The Authorized Officer may direct additional treatment of the road, as deemed necessary.

When construction has been completed, all disturbed areas beyond the road, ditch, or drainage facilities shall be recontoured to conform with local topography, and topsoil will be replaced, as directed by the Authorized Officer.

The on-lease portions of the mine access road will be upgraded and maintained consistent with the right-of-way grant C-37773 to Rio Blanco County Class D-Mountainous road standards:

Road Width:	Two 11-foot wide traffic lanes Two 7-foot wide shoulders
Total Width:	36 feet

Gravel: 8-inch thick base course of 3-inch gravel or pit run

4-inch thick coarse of 3/4-inch gravel

Total Gravel: 12 inches

Grade: Less than 8 percent

Curves: 24 degrees maximum

The lessee shall regularly maintain the road in a safe, usable condition. A regular maintenance program shall include, but not be limited to, blading, crowning, ditching, culvert installation, drainage installation, surfacing, and patrolling.

The operator shall post signs, visible within line of sight, indicating location of the underground water pipeline and electric cable providing name, address, and telephone number of a responsible contact person.

All pipelines adjacent to or crossing access roads shall either be buried with a minimum of 4 to 5 feet of cover in alluvial areas and a minimum of 3 feet of cover in rocky areas, or they will be otherwise protected from road maintenance and construction activity.

New roads shall not be built in conjunction with the water pipeline and electric cable authorized herein. Access along the approved water pipeline route is not authorized except in the event of an emergency. At all points of potential vehicular access, the designated operator/lessee shall construct barricades to keep vehicles off, thereby enhancing reclamation success.

Before construction of the 4-inch water pipeline, the designated operator/lessee shall submit to the Authorized Officer a construction plan that shall include engineering/construction designs to be employed to minimize the potential for pipeline ruptures and other problems as a result of freezing, etc.

Culverts and/or other measures may be necessary to control surface water runoff from the access road and adjacent areas so as not to impede natural drainage or create erosional hazards. Placement and construction is subject to direction and/or approval by the Authorized Officer.

2.3.2 Proposed Action

Wolf Ridge Corporation's proposal involves construction and operation of a commercial-scale nahcolite solution mine at a maximum production level of 125,000 tons per year (tpy) over a 30-year period. This action would essentially be an expansion (Phase III) of WRC's approved pilot-scale operation (Phase II), as described under the No Action Alternative. The proposal is for phased-approach modular development. Initial production would begin at approximately 50,000 tpy, with an anticipated increase to 125,000 tpy in the second or third year of operation. Map 2-1 shows the location and components of the Proposed Action. Further detail is shown on Map 2-4. Specific details of this alternative are described in the following subsections.

2.3.2.1 Plant Site Facilities

No additional acreage would be required outside of the 5 acres identified under the No Action Alternative (i.e., Pilot Plant) for plant site facilities, although facilities themselves would be expanded to accommodate a 30-year commercial project.

2.3.2.2 Well Field Operations

Approximately 215 acres of additional land would be associated with expansion of the well field from the pilot project (i.e., No Action Alternative). Eleven cavities would be mined annually, involving the drilling of 22 production wells each year. Over the 30-year life of the mine, 330 cavities would be mined, involving 660 production wells.

2.3.2.3 Evaporation Ponds

Three additional evaporation ponds encompassing approximately 22 acres would be required for the 125,000 tpy project. These three ponds, in addition to the existing pond, would total approximately 12 acres of evaporation surface for waste water disposal.

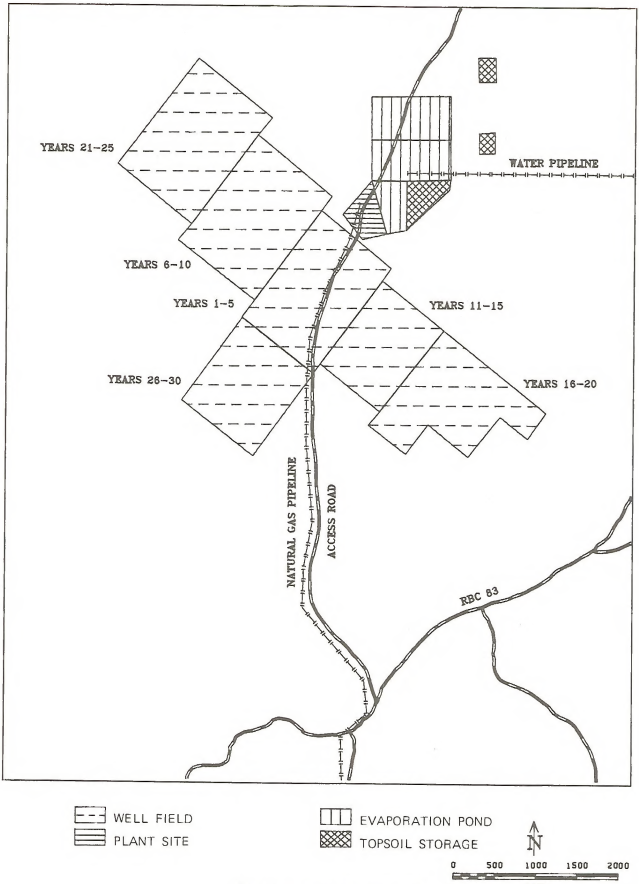
2.3.2.4 Product Handling and Transport

All produced material would be bagged within an enclosed 80- by 100-foot bagging building. Haulage trucks would make approximately 21 round trips per day, 5 days per week, between the plant site and the Lacy Station storage/handling facility west of Rifle.

2.3.2.5 Utilities

Electrical power would be generated on-site using five natural gas-fired cogeneration units. Natural gas would be brought into the plant site via a 4-inch diameter buried pipeline. This proposed pipeline, which would be approximately 2.5 miles in length, would tap into an existing natural gas pipeline in the SE1/4 of Section 2, Township 2 South, Range 98 West. Map 2-1 shows the proposed route of this pipeline. WRC would have to acquire a right-of-way grant for the off-lease portion of this pipeline, pursuant to Section 28 of the Mineral Leasing Act of 1920, as amended. Construction of this pipeline would involve disturbance of approximately 17 acres of public land.

Approximately 150 gpm (219 acre-ft/year) of water would be required for mine operation and process facilities.



(125,000 TPY)
PROPOSED ACTION ALTERNATIVE
MAP 2-4

2.3.2.6 Access

The Proposed Action would require further upgrading of the access road to standards meeting or exceeding Rio Blanco County Class C-Mountainous standards. The 36-foot wide road surface would consist of a compacted 12-inch layer of clean pit-run gravel covered by a 6-inch surface of processed road gravel. A 24-foot wide bituminous pavement would then be placed in a 2-inch base coarse followed by a 1 1/2-inch wearing coarse. The roadway would be crowned for drainage and the curves would be super elevated. The road would have a maximum 8 percent grade and would be designed for a speed of 35 miles per hour. Guard rails or berms would be provided, as required, by published safety standards.

Vehicular traffic to and from the plant site, 5 days per week, is estimated as follows:

26-ton haul trucks—21 round trips per day
Light duty trucks and autos—27 round trips per day
Supply trucks—3 round trips per day

It is expected that the bulk of this traffic would travel between Rifle and the project site.

2.3.3 50,000 TPY Alternative

This alternative would involve expansion from the approved pilot-scale project to a commercial-scale operation producing 50,000 tpy of sodium bicarbonate over a 30-year period. Map 2-5 shows the location and components of this alternative. Further detail is shown on Map 2-6. Specific details of this alternative are described in the following subsections.

2.3.3.1 Plant Site Facilities

No additional acreage would be required outside of the 5 acres associated with the approved pilot-scale project (i.e., No Action Alternative), although facilities themselves would be expanded to accommodate a 30-year commercial project.

2.3.3.2 Well Field Operations

Approximately 90 acres of additional land would be associated with expansion of the well field. Four and one-half cavities would be mined annually, involving the drilling of 10 production wells each year. Over the 30-year life of the mine, 135 cavities would be mined, involving 270 production wells.

2.3.3.3 Evaporation Ponds

Two additional evaporation ponds, encompassing approximately 10 acres, would be required for the 50,000 TPY Alternative. These two ponds, in addition to the existing pond, would total approximately 5 acres of evaporation surface for waste water disposal.

2.3.3.4 Product Handling and Transport

All produced material would be bagged within an enclosed bagging building. Haulage trucks would make approximately nine round trips per day, 5 days per week, between the plant site and the Lacy Station storage/handling facility west of Rifle.

2.3.3.5 Utilities

Natural gas would be utilized for on-site generation of electrical power as described under the Proposed Action, except that only three cogeneration units would be necessary.

Approximately 80 gpm (117 acre-ft/year) of water would be required for mine operation and process facilities.

2.3.3.6 Access

Further upgrading of the access road from that associated with the approved pilot-scale operation would not be necessary. Periodic maintenance to ensure adherence with Rio Blanco County Class D-Mountainous standards (as described in the "Access" section of the No Action Alternative) would be required.

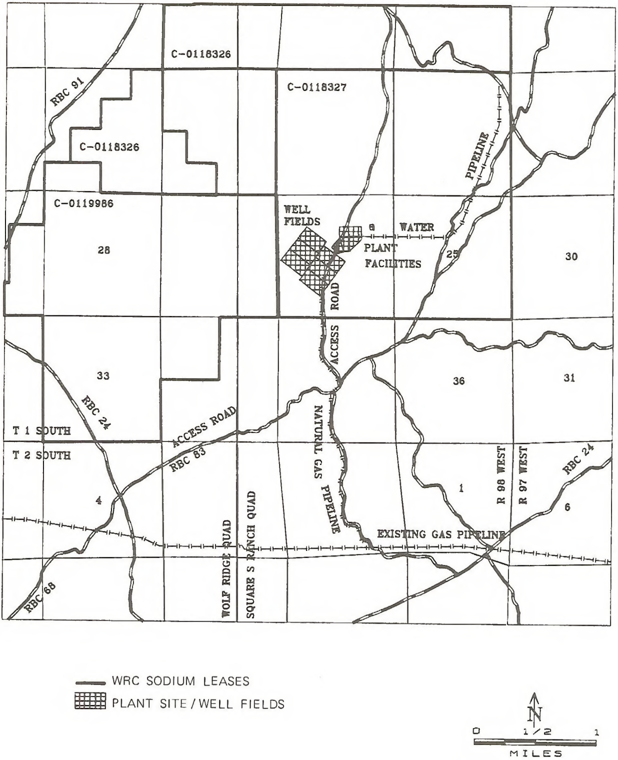
Vehicular travel to and from the plant site, 5 days per week, is estimated as follows:

26-ton haul trucks—9 round trips per day
Light truck and autos—18 round trips per day
Supply trucks—2 round trips per day

It is estimated that the bulk of travel would be between Rifle and the plant site.

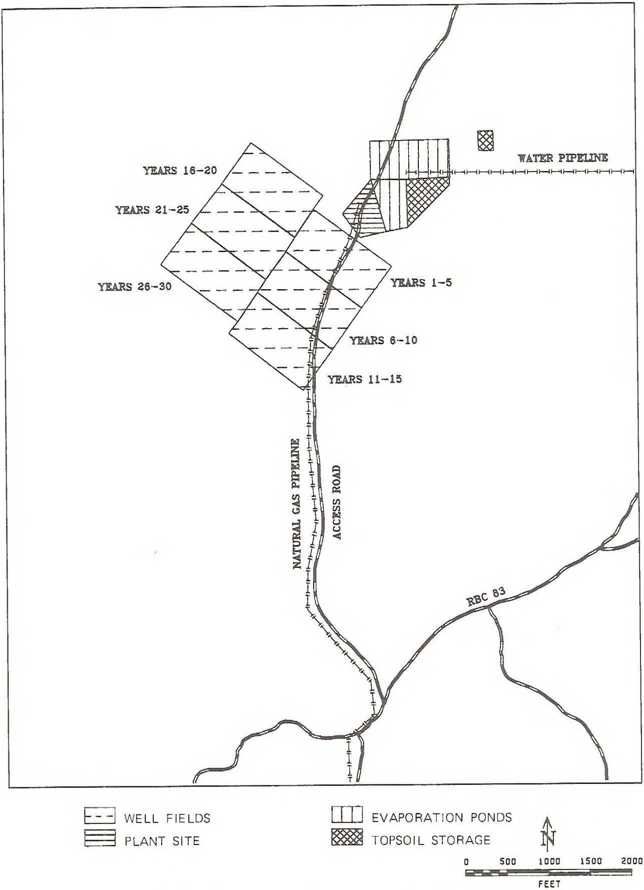
2.3.4 500,000 TPY Alternative

This alternative would involve expansion from the approved pilot-scale project to a commercial-scale operation producing 500,000 tpy of sodium bicarbonate over a 30-year period. Map 2-7 shows the location and components of this alternative. Further detail is shown in Map 2-8. Specific details of this alternative are described in the following subsections.



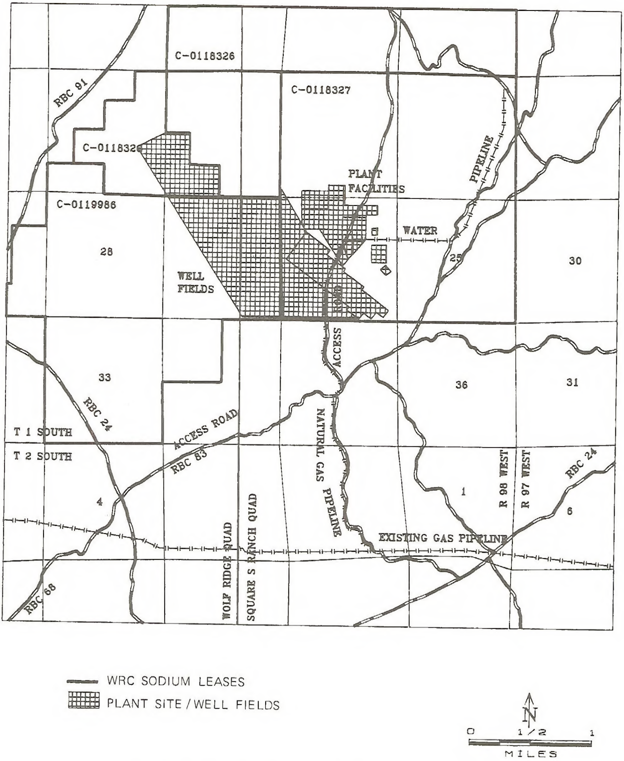
50,000 TPY ALTERNATIVE

MAP 2-5



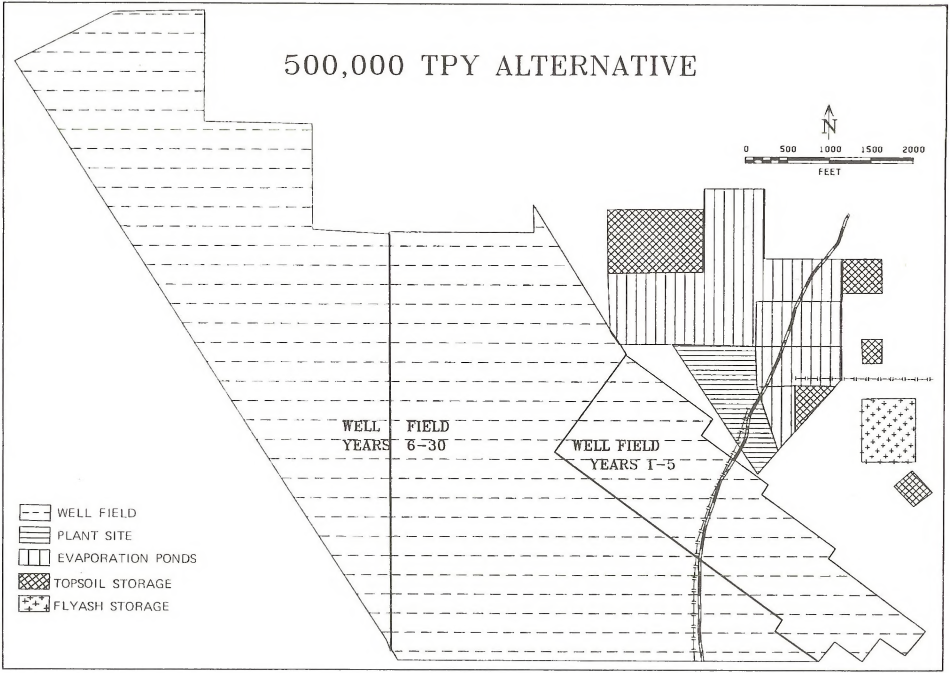
50,000 TPY ALTERNATIVE

MAP 2-6



500,000 TPY ALTERNATIVE

MAP 2-7


500,000 TPY ALTERNATIVE
N
0
500
1000
1500
2000
FEET
WELL FIELD
YEARS 6-30
WELL FIELD
YEARS 1-5
WELL FIELD
PLANT SITE
EVAPORATION PONDS
TOPSOIL STORAGE
FLYASH STORAGE

MAP 2-8

2.3.4.1 Plant Site Facilities

An additional 16 acres of land would be disturbed in association with expansion of sodium processing and handling facilities.

2.3.4.2 Well Field Operations

Approximately 802 acres of additional land would be associated with expansion of the well field. Forty-four cavities would be mined annually, involving the drilling of 88 production wells each year. Over the 30-year mine life, 1,320 cavities would be mined involving 2,640 production wells.

2.3.4.3 Evaporation Ponds

Seven additional evaporation ponds encompassing approximately 88 acres would be required for this alternative. These seven ponds, in addition to the existing pond, would total approximately 40 acres of evaporation surface for waste water disposal.

2.3.4.4 Product Handling and Transport

One hundred twenty-five thousand tpy of sodium bicarbonate would be handled and transported as described under the Proposed Action. The balance of the product (375,000 tpy) would be temporarily stored on-site in a 1,250-ton capacity bulk-storage silo. The silo would be elevated above grade and would allow for top loading of haulage trucks with 26-ton capacity covered hopper-style trailers. These bulk-loaded trucks, as well as trucks handling bagged product, would transport all material to a product handling/ storage facility at Lacy Station railhead west of Rifle.

Trucks delivering bulk product to the Lacy Station facility would be gravity unloaded into a 30-ton capacity below grade hopper. The bulk product would be transported to an 1,800-ton capacity storage silo via a pneumatic conveyor. The silo would be elevated and would span a railroad spur track to facilitate overhead loading into 95-ton capacity enclosed hopper-style rail cars.

Haulage trucks would make approximately 60 round trips per day, 7 days per week, between the plant site and the Lacy Station storage/handling facility.

2.3.4.5 Utilities

Commercial electricity would be required under this alternative. This would require construction of a 138 kV powerline into the plant site, although an exact route and power source tie-in has not been identified. Such a transmission line would have to be analyzed and authorized under the Title V right-of-way process upon submission of a formal application.

A coal-fired steam boiler would be required for producing process heat. This boiler would require consumption of approximately 144-tons per day of pulverized 10,650 Btu/ lb. coal. Coal would be trucked in from an unknown outside source and would be stored in one or two on-site 1,000-ton capacity storage silos. Approximately 16 tons of coal ash would be produced each day of operation. This ash would be disposed of in either: 1) an on-site clay lined land fill or, 2) through injection into mined-out cavities. Map 2-8 shows the location of the potential waste ash surface disposal pit. This surface disposal site would cover approximately 11 acres after 30 years of operation, assuming a 20-foot pile depth. If ash were disposed of in mined-out cavities, approximately one cavity per year would be filled, or 28 to 30 cavities for the life of the operation.

Approximately 600 gpm (875 acre-ft/year) of water would be required for processing and for potable purposes under this alterative. This would require a secondary water source other than the existing well in Section 24, Township 1 South, Range 98 West; however, a secondary water source or potential pipeline to the plant site has not as yet been identified. An exact well location and water pipeline location would have to be specifically identified and analyzed before BLM approval. An additional water storage tank would probably be required under this alternative.

2.3.4.6 Access

No further road upgrading other than that described under the Proposed Action would be required.

Vehicular traffic to and from the plant site, 7 days per week, is estimated as follows:

26-ton haul trucks — 60 round trips per day
Light trucks and autos — 84 round trips per day
Supply trucks — 6 round trips per day

2.4 Mitigation

Mitigation is defined as avoiding, minimizing, compensating, rectifying, reducing, or eliminating an adverse environmental impact (USDI, BLM 1983b). The mitigative measures presented in this section are actions that could reduce or eliminate the impacts identified in Chapter 4.

Two types of mitigative measures are presented: committed and uncommitted. Committed mitigation includes those measures put forth by Wolf Ridge Corporation in their Proposed Action Mine Plan. All of these applicant committed measures are listed and/or incorporated within either Section 2.2, General Development Components, or within the specific alternative descriptions in Section 2.3. In addition, committed mitigation includes those measures, as listed below, that would be applied by the BLM to the approved action in an effort to minimize or alleviate environmental impacts. Uncommitted mitigation are those measures that could be implemented through other agencies or committed to by the proponent in an effort to minimize environmental effects, but that the BLM cannot commit to or require because the measures are outside BLM's authority to enforce. These measures are listed in Chapter 4, Section 4.18.5.

2.4.1 Committed Mitigation

2.4.1.1 BLM Proposed Mitigation

The following mitigative measures will be applied to the approved action, regardless of the alternative, and are therefore considered committed. Some measures are unique to specific alternatives and are duly noted.

2.4.1.1.1 General

If additional construction material is necessary for development associated with the approved action, the designated operator/lessee shall submit an application to the Authorized Officer for authorization to obtain such material, if located on public lands.

The designated operator/lessee shall locate, handle, and store gas, oil lubricants, and other petroleum products in such a manner so as to prevent them from entering into and contaminating water resources and soils on the public lands.

The United States of America considers the development of groundwater resources to be necessary and frequently indispensable to effective land management. The United States shall have the first opportunity to file a state water right for any intercepted groundwater. The designated operator/lessee may file for water rights within the lease, only with a written waiver from the District Manager. The Bureau of Land Management concedes the existence of any water rights that the Wolf Ridge Corporation and its affiliates may own or control before the date of approval of this mine plan.

The Authorized Officer shall be contacted at least 24 hours prior to:

1. Surface disturbing construction or maintenance activity
2. Commencement of reclamation activity
3. Commencement of drilling and logging operations

Rights-of-way will be required for the off-lease portions of ancillary facilities covered under the approved mine plan pursuant to Title V of FLPMA and Section 28 of the Mineral Leasing Act of 1920, as amended.

2.4.1.1.2 Air Quality

Periodic watering of the access roads, well field roads and plant site will be carried out to control fugitive dust emissions. This stipulation will apply particularly from May through October. The Authorized Officer may direct additional treatment of the road, as deemed necessary.

For the 500,000 TPY Alternative, fabric filtration shall be utilized for the additional materials handling steps of bulk product packaging and truck loading. A baghouse or electrostatic precipitator and flue-gas desulfurization shall be applied to the coal-fired boilers.

2.4.1.1.3 Evaporation Pond

The designated operator/lessee will be required to pump and haul waste water from the evaporation ponds to an approved disposal site if the evaporation ponds reach or exceed their design capacity, unless otherwise approved in writing by the Authorized Officer.

The liners of the evaporation ponds will be underlain by a minimum of 4 inches of suitable soil material containing at least 95 percent material passing the No. 10 sieve (ASTM E-11 specifications) or other approved method.

A water-tight catchment basin or other approved method will be employed at the outlet of the leak detection system on each of the evaporation ponds to contain any leaked fluids.

A buffer zone of 15 feet of undisturbed vegetation will be maintained between the toe of the fill slope on the east side of the evaporation ponds and the edge of the adjacent major drainage.

Evaporation pond liner integrity will be maintained during periodic removal of solids. If the liner is damaged during solids removal operations, the liner shall be repaired to the satisfaction of the Authorized Officer.

2.4.1.1.4 Well Drilling, Completion and Abandonment

A temperature survey log shall be run, from the top of the cement behind the 8 5/8-inch well casing to the surface, within 14 days prior to abandoning any well bore and prior to pulling any 8 5/8-inch well casing.

A "Notice of Intent to Abandon" will be submitted by the designated operator/lessee to the Authorized Officer before abandonment of any well developed within this project. The notice will contain an "as-built" diagram of the well and will describe any changes from the approved abandonment/plugging procedures. The Authorized Officer will review and approve or approve with modifications the notice within 15 calendar days of receipt. No special form for this notice is required. As a minimum, the following plugs will be required: 1) a steel bridge plug will be placed at the base of the production casing; 2) 50 feet of cement will be placed above this plug; 3) a cement plug will be placed 50 feet below the Mahogany Zone through to 50 feet above the production casing stub; and 4) 65 feet of cement will be placed at the surface. The intervals between the cement plugs will be filled with 9 pound/gallon or heavier drilling mud. Other cement plugs may be required, based on analysis of the cement bond logs and the temperature survey log. An appropriate surface hole location marker will be installed at grade.

Well spacing between cavities shall be adequate to ensure a 20-foot width at the top of the pillars that separate the cavities.

Diverter lines for the blow out preventer shall be directed into a lined mud pit at least 125 feet from the well.

Adequate waiting-on-cement times shall be observed for all cementing operations to achieve a minimum of 500 psi compressive strength.

The annulus between the well bore and the 8 5/8-inch well casing will be filled with cement from the bottom of the hole to the top of the A-Groove, and a cement bond log shall be run for this interval.

Drilling fluid material will be contained in bentonite lined mud pits and hauled to evaporation ponds upon completion of drill holes, unless otherwise approved in writing by the Authorized Officer.

A yearly plan of development and summary of the activity for the previous year shall be submitted by February 1 of each year. The plan will include the following items:

1. Summary of the activity for the previous year including, but not limited to,
   a) Any new findings or developments,
   b) Acres disturbed, acres reclaimed,
   c) Wells drilled, plugged, converted to monitoring, etc.
2. Proposed operations for the coming year, including, but not limited to,
   a) Location and number of new wells to be drilled,
   b) Well field piping system layout, including location of pressure transducers, 6-inch drain line connection points, and valves.
   c) Number of acres to be disturbed and to be reclaimed.
3. Status of all surface facilities and wells not abandoned.
4. Any technical considerations and/or proposed changes in operation.
5. Map of mined-out cavities and identification of any subsidence areas.

Prior approval is necessary for any change made to informational submittals, monitoring, or operations.

2.4.1.1.5 Monitoring

Weekly monitoring of the mud gel in the annulus between the 13 3/8-inch surface casing and 8 5/8-inch well casing will be required and any observed changes and/or any remedial measures taken shall be reported monthly to the Authorized Officer.

The designated operator/lessee will be required to monitor two groundwater zones: the base of the lower aquifer and the B-Groove of the lower aquifer. The monitoring well(s) shall be equipped with a continuous graphic water-level recorder. The well(s) shall be sampled two times, 1 week apart, for major and trace constituents, as soon as completed and cleaned out properly, and sampled for major constituents at least once a month during solution mining. Monthly sampling shall continue for a period of up to 3 years (at the discretion of the Authorized Officer) after project cessation, at which time trace elements shall again be sampled. Any effects on the monitored zones detected during operations shall be reported to the Authorized Officer. Sampling frequency will be increased to at least once a week if effects to the monitored zones are recorded. The weekly samples will be analyzed for the field measurements and major constituents. The first weekly sample will be analyzed for trace constituents. If significant deviations from the baseline are recorded in the trace elements, analysis of samples for trace elements will continue. Analysis for only those trace elements which show a significant deviation from baseline will be required.

Unless otherwise authorized by the Authorized Officer, the well(s) shall be sampled for the following:

Field Measurements (Monthly)

temperature
pH
conductivity

Lab Analyses - Major Components (Monthly)

total dissolved solids

alkalinity
sodium
bicarbonate
carbonate

Trace Components
(Sample initially and if lower aquifer is affected)

arsenic
manganese
chromium
beryllium
molybdenum
zinc
lithium
sulfide
potassium
boron
chloride
aluminum
selenium
nickel
copper
bismuth
mercury
nitrate
magnesium
total phosphate
silica
dissolved organic carbon
cadmium
barium
vanadium
strontium
lead
bromide
calcium
fluoride
sulphate
iron

Lab analysis work must be performed by a laboratory approved by the Authorized Officer.

The designated operator/lessee will be required to complete a certain number of wells as dedicated hydrologic monitoring wells. These wells will supplement the proposed monitor wells and will be used for monitoring the groundwater for the life of the mine. The number and location of the dedicated hydrologic monitoring wells will be submitted by the applicant and approved by the Authorized Officer before initiating construction of the approved action. Monitoring of the groundwater will commence at least 6 months prior to the start of mining.

If leakage (brines) from cavities is detected in the base of the lower aquifer the operator will be required to either (1) extract the brines and dispose of them through surface treatment, evaporation, or deep well injection at approved facilities, or (2) contain the brines within the base of the groundwater system and within the boundaries of the sodium leases.

Discharge of water will not be allowed without prior written approval from the Authorized Officer of BLM.

A detailed monitoring system will be submitted by the designated operator/lessee to detect and determine:

1. Extent of caving
2. Impact on Mahogany Zone due to caving and/or pillar failure
3. Any surface subsidence
4. Actual cavity configuration

This design will be submitted to the Authorized Officer for approval. The Authorized Officer will approve or approve with modifications or disapprove the design within 30 days of receipt. The monitoring system will be in operation prior to sodium production and will continue for at least 3 years following project cessation, or longer if conditions warrant, as determined by the Authorized Officer.

2.4.1.1.6 Submittals

The following information shall be submitted to the Authorized Officer within 30 days after such data is obtained:

1. One copy of all hydrologic data obtained from drilling and monitoring
2. Copies of all downhole logs
3. Fluid injection and production volumes and corresponding pressures
4. The daily 5 ½-inch by 8 ⅝-inch annular pressure readings
5. Copies of the mud check sheets
6. Weekly monitoring data of the 13 ⅜-inch by 8 ⅝-inch annulus

The cement bond logs shall be submitted to the Authorized Officer within 10 days after logging.

The temperature survey log shall be submitted to the Authorized Officer before initiating any well abandonment.

Production from a cavity shall be stopped if production from the cavity meets the calculated production, based on the assumed cavity configuration.

Specific details and specifications for epoxy spray coatings of minor casing leaks will be provided to the Authorized Officer before initiating well construction.

The Authorized Officer will be notified of all spills, leaks and pressure losses within 24 hours of the occurrence during the week, or first thing Monday morning if the occurrence is on a weekend.

2.4.1.1.7 Reclamation

Interim reclamation measures may be necessary before project cessation, as determined by the Authorized Officer. In addition, erosion control measures may be necessary, as directed by the Authorized Officer.

Topsoil will be stripped to appropriate depths on all areas that will be disturbed by the proposed action and will be stockpiled for future restoration, as directed by the Authorized Officer. Topsoil stockpiles will be fenced with single strand wire and will be appropriately shaped, i.e., slopes 4:1 or less, to minimize erosion before seeding and to maximize vegetation establishment after seeding. Stockpiles will be adequately designated with signs. Topsoil shall not be used as pipeline padding or mixed with spoils.

Whenever possible, salvaged topsoil will be applied directly to recontoured areas, reducing to the greatest extent possible, long-term topsoil stockpiling.

Topsoil stockpiles and exterior cut and fill slopes of evaporation ponds will be seeded, as soon as possible, with the following interim reclamation seed mix to enhance viability of stockpiled topsoil and to minimize potential erosion problems with both stockpiles and evaporation pond:

Species	**Variety**	**Pounds Pure Live Seed/Acre**
Grasses		
Pubescent wheatgrass	Luna	4
Thickspike wheatgrass	Critana	2
Forb		
Alfalfa	Ladak *	2

* preinoculated

Wherever possible, at least 12 inches of topsoil will be reapplied to disturbed areas after recontouring. When topsoil availability precludes a 12-inch application rate, as much topsoil as is available will be applied, but in no case will reapplied topsoil depth be less than 6 inches.

Reclamation will be initiated as soon after disturbance as possible, or as directed by the Authorized Officer.

Surface disturbing activities shall not be performed during periods when the soil is too wet to adequately support equipment. If equipment creates ruts in excess of 3 inches deep, the soil shall be deemed to be too wet to adequately support equipment. Mud blading is not considered an alternative to meeting the criterion in this stipulation.

Blading of vegetation or surface leveling of the area between wells comprising a well pair will not be allowed without prior documented authorization from the Authorized Officer.

The designated operator/lessee will be responsible for monitoring reclaimed areas for at least three complete growing seasons after final reclamation work is completed. Monitoring will continue to be required until reclamation goals are successfully achieved and reclamation qualifies for bond release. Monitoring methods are subject to the approval of the Authorized Officer and will quantify the following elements (at a minimum):

1. Vegetative production
2. Crown cover
3. Plant composition

Reclamation will be considered for approval and bond release only after the results of monitoring are presented to BLM. Reclamation will be considered a failure and remedial measures required prior to bond release if one or more of the following conditions persist:

1. Production of herbaceous perennial species by category (forb, grass) is less than that measured on representative undisturbed areas.
2. Shrubs comprise less than 12 percent and perennial forbs less than 4 percent of the established plant composition by cover.
3. Perennial crown cover is less than that measured on representative undisturbed areas.
4. Soil erosion rates on reclaimed areas exceed these of representative undisturbed areas.

All merchantable forest products within the project development area that are taken, damaged, or destroyed will be purchased by the designated operator/lessee at the total appraisal price, to be determined by the Authorized Officer, Bureau of Land Management (BLM), White River Resource Area. Disposal will be as follows:

All stems, stumps and branches over 4 inches in diameter shall be: a) removed from federal land for resale or private use, or b) cut into lengths not exceeding 4 feet and scattered away from the disturbance. All stems and branches less than 4 inches in diameter shall be evenly scattered away from the disturbed area.

Annual or noxious weeds shall be controlled on all disturbed areas as directed by the Authorized Officer. Method of control shall be by an approved mechanical method or an EPA registered herbicide. All herbicide application proposals must be under direct field supervision of an EPA certified pesticide applicator.

The species mixture submitted in the mine plan for use in reclamation is amended as follows:

Species	Variety	Pounds Pure Live Seed/Acre
Grasses		
Thickspike wheatgrass	Critana	0.50
Streambank wheatgrass	Sodar	0.50
Western wheatgrass	Arriba	1.00
Pubescent wheatgrass	Luna	0.50
Basin wildrye	Magnar	0.50
Russian wildrye	Vinall	0.50
Green needlegrass	Common	2.00
Orchardgrass	Paiute	0.25
Forbs		
Lewis flax	Apar	0.20
Cicer milkvetch	Monarch *	0.50
Alfalfa	50% Ladak *	0.75
	50% Nomad *	0.75
Small burnet	Delar	1.00
Shrub		
Fourwing saltbush	Rincon (dewinged)	1.50
Winterfat		0.50
Antelope bitterbrush		1.00

* preinoculated

The quantity of seed applied on-the-ground will be determined on a Pure Live Seed (PLS) basis, PLS being defined as "tested purity rate" x "tested rate of germination." For example, the quantity of western wheatgrass seed (95 percent purity, 70 percent germination) needed to meet a stipulated 1.0 pound PLS/acre application rate:

Actual applied seed rate = required PLS rate (lb per acre) ÷ PLS index = 1.0 lb per acre ÷ 0.9 x 0.70 = 1.5 lb per acre

Site-adapted, tested seed for the current year is required and is subject to the approval of the Authorized Officer (copies of the seed labels will be furnished to the Authorized Officer).

Specific cultural practices that promote the establishment and survival of seeded forbs and shrubs will be employed where practicable, subject to the approval of the Authorized Officer.

On-site burial of concrete or asphalt at the time of sodium mine site decommissioning is subject to prior approval of the Authorized Officer.

The designated operator/lessee shall promptly remove and dispose of all waste to an approved landfill, as directed by the Authorized Officer. The term "waste" as used herein means all discarded matter including, but not limited to, human waste, trash, garbage, refuse, petroleum products, ashes, and equipment.

Drainages shall not be blocked with loose dirt or debris.

Before termination of the authorized facilities, the designated operator/lessee shall contact the Authorized Officer to arrange a joint inspection of the facilities and disturbance. The inspection will be held to determine if any reasonable and necessary changes, revisions, or additions need to be made to the approved restoration and rehabilitation plan.

Reclaimed areas will be fenced off with four strand barbed wire fence with braced corner posts conforming to BLM Type D fence specifications (Appendix A). Reclaimed areas shall remain fenced so as to effectively exclude livestock use for a minimum of three complete growing seasons following final reclamation work and until bond release is approved by the Authorized Officer.

2.4.1.1.8 Range and Wildlife

All powerlines and electric transmission facilities (aboveground) will conform to accepted raptor protection design criteria as presented in: Suggested Practices for Raptor Protection on Powerlines — State of the Art in 1981, Raptor Research Report No. 4, Raptor Research Foundation, Inc., c/o Dept. Veterinary Biology, University of Minnesota. St. Paul, Minnesota 55101.

Upon completion of BLM's Section 7 Consultation requirements with the U.S. Fish and Wildlife Service, any threatened and endangered species conservation measures developed through the Section 7 Consultation process will be imposed on the designated operator/lessee.

In the event any raptor nest site is encountered during facility siting or well field construction, the designated operator/lessee shall notify the Authorized Officer immediately. Appropriate mitigative measures will be formulated at this time by the White River Resource Area Manager, if necessary.

Where the Authorized Officer determines that consumption of contaminated water will be detrimental to animals, the designated operator/lessee shall prevent access by appropriate fencing with 8-foot high woven wire or chain link fence. The evaporation ponds shall be fenced as such.

The applicant will be responsible for offsetting short-term mule deer habitat losses associated with well field development and life-of-mine facilities. Under the direction of BLM, the designated operator/lessee shall be responsible for implementing mule deer habitat enhancement practices within the Piceance Basin at 5-year intervals through mine life. Habitat enhancement measures will be based on the extent of mule deer habitat lost or made unavailable over each 5-year period, from the first year of development through end of mine life (Environmental Consequences, Mule Deer). Specific practices that would be considered include, but are not necessarily limited to:

1. Mechanical brush manipulation
2. Range seeding
3. Prescribed burns
4. Water developments

The performance goal for mule deer habitat mitigation shall be to replace forage resources effectively lost over each 5-year period. BLM and the designated operator/lessee, in coordination with Colorado Division of Wildlife, will appraise habitat losses, determine habitat enhancement needs, and formulate project methodology and design. All mitigation work will be subject to the approval of the BLM.

The designated operator/lessee shall be responsible for conducting annual raptor breeding activity inventories in pinyon-juniper habitats affected by well field development through mine life. These surveys shall be conducted by qualified personnel with demonstrated training and practical field experience in raptor behavior and breeding biology. The surveys will be conducted during May or June of each year and will encompass a study area which is comprised of that portion of the well field which would be affected 2 years in advance of current mining activity and a 500-foot buffer around the principal study area. Results of annual inventory will be furnished to BLM by September 1 of each year. The designated operator/lessee shall remain responsible for executing emergency or remedial mitigation for newly initiated or previously undiscovered raptor nesting activity jeopardized by well field development, as directed by BLM in coordination with the U.S. Fish and Wildlife Service.

No unnecessary removal of pinyon pine or Utah juniper trees or snags will be allowed within the well field, particularly in that area between wells comprising a well pair. One year prior to preparative clearing of sites within the well field, individual trees which require removal must be identified for inspection and their removal approved of by the Authorized Officer and/or White River Resource Area wildlife biologist.

2.4.1.1.9 Archaeology/Paleontology

If in its operations, the designated operator/lessee discovers any cultural remains, monuments or sites, or any object of antiquity subject to the Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C. Sec., 431-433), the Archaeological Resources Protection Act of 1979 (Public Law 96-95), and 43 CFR, Part 3, the designated operator/lessee shall immediately cease activity and report directly to the Area Manager. BLM will then take necessary action to comply with the above legislation. The designated operator/lessee shall follow the mitigative requirements set forth by the BLM concerning protection, preservation, or disposition of any sites or material discovered. All known and identified sites will be avoided by project design. If this is not prudent and feasible, consultation with the State Historic Preservation Officer (SHPO), as specified in 36 CFR 800, will be required. In cases where mitigation is necessary, the cost of such mitigation shall be borne by the designated operator/lessee, unless otherwise agreed upon.

The designated operator/lessee shall not knowingly disturb, alter, destroy, or take any fossils of significant scientific interest, and shall protect all such fossils in conformance with the measures included in the approval of the mining plan.

The designated operator/lessee shall immediately report any such fossils that might be altered or destroyed by his operation to the attention of the District Manager. Operations may continue as long as the fossil specimen or specimens will not be seriously damaged or destroyed by the activity. The District Manager shall evaluate or have evaluated such discoveries brought to his attention and, within five working days, shall notify the designated operator/lessee what action shall be taken with respect to such discoveries. All such fossils of significant scientific interest shall remain under the jurisdiction of the United States until ownership is determined under applicable law. Copies of all paleontological resource data generated as a result of the lease operations will be provided to the District Manager. The cost of any required salvage of such fossils shall be borne by the designated operator/lessee. These conditions apply to all such fossils of significant scientific interest discovered within the lease area.

2.4.1.1.10 Roads and Pipelines

For the 50,000 TPY Alternative, access road upgrading shall be constructed and maintained in accordance with BLM 9113 guidelines and Class D-Mountainous Rio Blanco County Road standards.

For the Proposed Action (125,000 TPY) and 500,000 TPY alternatives, access road upgrading shall be constructed and maintained in accordance with BLM 9113 guidelines and Class C-Mountainous Rio Blanco County Road standards.

The designated operator/lessee shall regularly maintain the road in a safe, usable condition. A regular maintenance program shall include, but not be limited to, blading, crowning, ditching, culvert installation, drainage installation, surfacing, and patrolling.

The designated operator/lessee shall post signs, visible within line of sight, indicating location of the underground water pipeline and electric cable, providing name, address, and telephone number of a responsible contact person.

All pipelines adjacent to or crossing access roads shall either be buried with a minimum of 4 to 5 feet of cover in alluvial areas and a minimum of 3 feet of cover in rocky areas, or they will otherwise be protected from road maintenance and construction activity.

Culverts and/or other measures may be necessary to control surface water runoff from the access road and adjacent areas so as not to impede natural drainage or create erosional hazards. Placement and construction is subject to direction and/or approval by the Authorized Officer.

Operator shall paint all permanent structures (on site for a period longer than 90 days after construction) a flat, noncontrasting color harmonious with the adjacent landscape. Exceptions to this requirement are small structures that are not readily visible from a distance of approximately 1/4 mile such as wire and small pipe or structures which, because of OSHA requirements, require safety coloration. Specific colors appropriate for the various landscapes are Cypress Gray, 11-M-38, or equivalent.

2.5 Baseline

In order to assess the cumulative impacts of the analyzed project alternatives, a baseline had to be established upon which to add the incremental impacts of sodium development. The baseline, which is made up of past, present, and reasonably foreseeable future projects occurring in the same general area, utilizes recommendations from the Cumulative Impact Task Force (CITF) computer models. Only the projects that were deemed most likely to be constructed within a reasonable time frame as of January 1985 were included and projected for 20 years to the year 2005. A major assumption put forth in this baseline is that none of the considered oil shale projects will be commercially producing shale oil at a sustained rate, with the exception of the Union Shale Oil Project, until the year 2000. This is based primarily upon current and projected economics in the world oil market, in addition to necessary capital costs and lead time for project development if conditions were to become favorable for commercial shale oil.

The baseline level of development for the region, as described in the following subsections, would be in addition to the description of the No Action Alternative for development of the pilot-scale sodium solution mine in Chapter 2. In this analysis, No Action would mean that escalation of the approved 2-year maximum pilot-scale sodium project (Phase II) to a commercial-scale project (Phase III) would not occur.

2.5.1 Federal Oil Shale Development

Federal Oil Shale Lease Tract C-a is currently managed by Rio Blanco Oil Shale Company (RBOSC). It is presently under a temporary lease suspension issued by the Department of the Interior in August of 1982. As the result of a proposal submitted by RBOSC to lease 6,400 acres on 84 Mesa adjacent to Tract C-a for offtract disposal of overburden and spent shale, the BLM completed a draft environmental impact statement in September of 1985 analyzing the proposal and three other alternatives. As a result of the EIS, BLM identified the 84 Mesa site as the preferred alternative. As such, this baseline assumes that RBOSC will be issued a lease for offtract disposal of spent shale and overburden on 84 Mesa in or around 1987.

Based upon information contained within the Draft EIS, this baseline assumes that Tract C-a would be producing approximately 33,000 barrels per day (bbl/day) of shale oil in 2000 with that level sustained through 2005. Open-pit mining with offtract disposal of overburden/spent shale is expected to yield 1.3 billion barrels of shale oil over a 56-year project life. Peak construction levels would occur from 2000 to 2005.

Distribution of the estimated permanent work is expected to be 50 percent in Rifle, 20 percent in Meeker, 5 percent in Rangely, 10 percent in Silt, 10 percent in New Castle, and 5 percent in Grand Junction. The steady state work force is expected to be approximately 1,750 by year 2005.

Production of 33,000 bbls/day is expected to require approximately 6,200 acre-feet/year of water, which would be derived primarily from the existing groundwater below Tract C-a. By the year 2005, approximately 4,700 acres of surface disturbance would have occurred.

The other Prototype Federal Oil Shale Lease, Tract C-b, is currently managed by Occidental Oil Shale Corporation. Development of the tract was originally proposed as an underground mine with surface retorting. These plans changed with their 1984 submittal of the "Revised Detailed Development Plan (DDP)," which incorporated modified in situ retorting. Price guarantees and a loan from the U.S. government were sought in an effort to start commercial operations; however, these were recently denied.

Based upon information contained in the 1984 Revised DDP, this baseline assumes that Tract C-b would be producing approximately 14,100 barrels per day (bbl/day) of shale oil in 2000, with that level sustained through 2005. The production expectancy for mining the upper oil shale zone of Tract C-b is approximately 34 years. Mining of the lower zones on C-b would add considerably to project life. Peak construction levels would occur from 2000 to 2005.

Distribution of the estimated permanent work force is based on the Cathedral Bluffs Shale Oil Company socioeconomic assessment surveys. This distribution is expected to be 60 percent in Rifle, 25 percent in Meeker, 10 percent in Silt, and 5 percent in other locations. The steady state work force is expected to be approximately 1,020 workers.

Production of 14,100 bbls/day is expected to require approximately 2,263 acre-feet/year of water, which would be derived primarily from the existing groundwater below Tract C-b. By the year 2005, approximately 675 acres of surface disturbance would have occurred.

Other federal oil shale activities such as the Naval Oil Shale Reserves, the Bureau of Mines research site, and Prototype Tracts C-11 and C-18 have not significantly changed since they were proposed or since operations have ceased. Because of the present inactivity and the low probability that any further action is likely to take place on these projects, they were not considered a part of the baseline for the purposes of impact assessment in this EIS. For further information on the status of these projects, see the "Current Management Alternative" description in Volume 1 of the Draft Piceance Basin RMP/EIS, released in April 1984.

2.5.2 Private Oil Shale Development

Private oil shale operations considered in the baseline of this EIS involve the Colony (Exxon) Project and the Union Shale Oil Project on Parachute Creek, the Chevron Clear Creek Project on Clear Creek and Skinner Ridge, and the Pacific Shale Oil Project on Clear Creek. Together these projects are anticipated to have the following magnitude of development.

1. Construction of these sites has either started or is assumed to start by 2000. The exception to this is the Colony Project, which is assumed to be under custodial management for an indefinite period of time.
2. Employment is expected to be approximately 1,250 in 1990, 1,885 in 1995, 7,935 in 2000, and 13,105 in 2005.
3. Peak shale oil production in bbl/day is anticipated to be: 30,000 in 1990 (Union only), 50,000 in 1995 (Union only), 131,400 in 2000, and 193,800 in 2005.
4. The regional socioeconomic impact from these projects is anticipated to be the same as described in the "No Action Alternative" of the Final Supplemental EIS for the Prototype Oil Shale Leasing Program, released in January 1983. It is summarized as follows. Employees (excluding Union) will live in the following communities: Grand Junction, 10 percent; Clifton, 1 percent; DeBeque, 30 percent; Parachute, 16 percent; Rifle, 14 percent; Battlement Mesa, 25 percent; Glenwood

Springs, 1 percent; Silt, 1 percent; New Castle, 1 percent; other, 1 percent.

By county this would be: Garfield, 58 percent; Mesa, 41 percent; and other, 1 percent.

Union Oil Company will have 28 percent of their employees in Rifle, 19 percent in Grand Junction, 13 percent in Parachute, and the remainder on the mine site camp.

5. Water use of the companies would total 4,766 acre-feet/year in 1990, 7,943 acre-feet/year in 1995, 24,119 acre-feet/year in 2000, and 38,865 acre-feet/year by 2005. Water will come from either groundwater sources below the project area or from the Colorado River.
6. Total disturbed acres would be approximately 2,469 acres by 2005.

2.5.3 Oil and Gas

Oil and gas exploration and development is expected to continue in the same manner as described in the "No Action Alternative" of the Final Supplemental EIS for the Prototype Oil Shale Leasing Program, issued January 1983, with the following changes.

Oil and gas production and development has slowed in the region, resulting in only 6 to 11 wells being drilled annually at depths ranging from 4,000 to 20,000 feet. This would require only 10 to 28 acre-feet of water annually and would result in a surface disturbance of 57 to 87 acres per year. In the Rio Blanco County region, oil and gas production and exploration employment involves approximately 326 workers.

2.5.4 Coal

Coal, although peripheral to Piceance Basin, is being developed in the Scullion Gulch area east of Rangely at the Deserado Mine. This mine supplies coal to the Moon Lake Power Project near Bonanza, Utah. At full production, the coal mine will supply the project with 2.4 million tons of coal per year by the year 2005. Coal will be transported by rail to Bonanza. Peak employment will occur in the year 2005, with 410 employees living primarily in Dinosaur and Rangely. Total surface disturbance will be 900 acres by 1995 and will reach a maximum of 1,000 acres by 2005. Water use will be 367 acre-feet/year, derived from four alluvial wells drilled adjacent to the White River.

TABLE 2-1

SUMMARY TABLE SHOWING MAJOR DIFFERENCES BETWEEN ALTERNATIVES

	Alternatives			
Item	No Action (Pilot Plant)	Proposed Action (125,000 TPY)	50,000 TPY	500,000 TPY
Project life	2-year maximum	30-year	30-year	30-year
Peak construction work force	40	128 [a]	84	200 [a]
Operational employment	13	45	36	85
Operating Schedule	330 days/yr, 24 hrs/day 7 days/week	Same	Same	Same
26-ton capacity haulage trucks, round trips/day-days/week	3-5	21-5	9-5	60-7
Supply trucks, round trips/day	1	3	2	6
Light duty trucks and autos, round trips/day	12	27	18	84
On-site product bagging amount	47,000 tpy	125,000 tpy	50,000 tpy	125,000 tpy
Storage of bagged product	None on-site, some in Rifle	On-site and at Lacy Station	All on-site	On-site and at Lacy Station
Bulk product load out and transfer to Lacy Station	None	None	None	375,000 tpy
Evaporation ponds number/acres	1/5	3/22 [b]	2/10 [b]	4/88 [b]
Electric power generation	2 850 kw diesel fueled generators	5 natural gas fired cogeneration units	3 natural gas fired cogeneration units	Commercial via 138 kV powerline into plant site.
Process heat generation	2 250 HP diesel fueled boilers	1 natural gas fired boiler	1 natural gas fired boiler	1 Coal fired steam boiler
Coal fly ash disposal	None	None	None	16 tons/day injected into mined-out cavities or clay lined disposal pit.
Water requirements gpm (ac-ft/year)/no. of wells	60 (88)/1	150 (219)/1	80 (117)/1	600 (875)/2 [c]
Energy requirements per year/project life (Btus x 10^{10})	19.58/39.16	43.84/1,315.00	17.52/525.60	119.40/3,582.00
Production wells drilled Annually/over project life	2-4/6	22/660	9/270	88/2,640
Cavities mined annually/over project life	1-2/3	11/330	4.5/135	44/1,320
Access road/acres disturbed	Existing-graveled/18	Paved/no additional	Graveled/no additional	Paved/no additional
Plant site acreage	5	No additional	No additional	16 [b]
Well field acreage (project life)	4	215 [b]	90 [b]	802 [b]
Topsoil stockpile acres	4	3 [b]	1 [b]	26 [b]
H_2O well and pipeline acreage	7	No additional	No additional	Not known[c]
Natural gas pipeline acreage	None	17	17	17
Total acreage over mine life	43	257	118	960

[a] Assumes phased construction.

[b] In addition to no action.

[c] Secondary water source and pipeline route not known.

TABLE 2-2

SUMMARY OF IMPACTS

	Alternatives			
Resource	**No Action (Pilot Plant)**	**Proposed Action/125,000 TPY**	**50,000 TPY**	**500,000 TPY**
Air Quality	Small amount of local degradation for pollutants (primarily particulates, CO, SO_2, and NO_2) for 2-year maximum project life.	Same, except for 30 years.	Same, except for 30 years.	Potentially significant degradation from particulate emissions for 30 years—exceedance of Class II PSD increments.
	No affect to Class I/Category I AQRVs.	Same	Same	Potential adverse impact to Class I/Category I AQRVs from acid (nitrate and sulfate) deposition.
Topography	No impact	Potential surface subsidence of less than 1 foot.	Same as proposed action.	Same as proposed action.
Rock Quality	Strata immediately overlying the cavities significantly reduced. Mahogany Zone not significantly affected.	Same	Same	Same
Fluid Minerals	No affect to oil and gas resource. Future development of surface facilities and well drilling operations would be complicated.	Same	Same	Same
Solid Minerals	No significant adverse impacts expected to overlying oil shale resources.	Same	Same	Same
	Sodium resources within the L-5E Bed potentially impacted should collapse of cavity roofs or pillar failure occur.	Same	Same	Same
	Sodium resources mined would be comsumed; remaining sodium resources potentially forgone as pillars for subsidence control.	Same	Same	Same
Water Resources				
Water Quantity	No measurable reduction of stream flow.	About 5% reduction in average daily flow from Yellow Creek. .4% reduction from Piceance Creek. Any depletion is considered significant because of over allocation of surface water in the Piceance Basin.	About 2% reduction in average daily flow from Yellow Creek. .1% reduction from Piceance Creek. Considered significant.	About 23% reduction in average daily flow from Yellow Creek. 2% reduction from Piceance Creek. Considered significant.

TABLE 2-2 (Continued)

SUMMARY OF IMPACTS

	Alternatives			
Resource	**No Action (Pilot Plant)**	**Proposed Action/125,000 TPY**	**50,000 TPY**	**500,000 TPY**
Water Quality (continued)	No significant impact.	No significant impacts to water quality by direct contamination. Approximately 20% increase in the area of the base of the groundwater system in contact with salt within the lease tracts. This is a 1% increase in the total area of the aquifer system in contact with salt in the Piceance Basin. This is a locally significant impact but is not regionally significant.	No significant impacts to water quality by direct contamination. Approximately 10% increase in the area of the base of the groundwater system in contact with salt within the lease tracts. This is a 0.5% increase in the total area of the aquifer system in contact with salt in the Piceance Basin. This is not considered a significant impact.	No significant impacts to water quality by direct contamination. Approximately 80% increase in the area of the base of the groundwater system in contact with salt within the lease tracts. This is a 4% increase in the total area of the aquifer system in contact with salt in the Piceance Basin. This is a locally significant impact but is not regionally significant.
Soils	Undeterminable loss of soil from wind and water erosion on disturbed areas.	Same	Same	Same
	Alteration of natural soil horizons; decrease in diversity of soil communities as a result of disturbance on 43 acres.	Same on 257 acres.	Same on 118 acres.	Same on 960 acres.
Vegetation	Natural vegetative communities lost to surface disturbance on 43 acres.	Same on 257 acres.	Same on 118 acres.	Same on 960 acres.
	Reclamation effort expected to return disturbed areas to production levels equal to or greater than predisturbance.	Same	Same	Same
	Remnant Vegetation Association (RVA) not affected.	78% of RVA destroyed.	Same as Proposed Action.	89% of the RVA destroyed.
Livestock Grazing	Forage production lost on disturbed areas resulting in a loss during the project life of 3-6 AUMs.	4 AUMs lost for project life.	2 AUMs lost for project life.	10 AUMs lost for project life.

TABLE 2-2 (Continued)

SUMMARY OF IMPACTS

Resource	No Action (Pilot Plant)	Proposed Action/125,000 TPY	50,000 TPY	500,000 TPY
Wildlife	Average 59-acre loss of mule deer winter range habitat at any given time over mine life—reducing Piceance Basin's carrying capacity threshold tolerance by 0.5 percent (see text).	Average 173-acre loss over mine life. Carrying capacity reduction of 1.3 percent.	Average 132-acre loss over mine life. Carrying capacity reduction of 1 percent.	Average 345-acre loss over mine life. Carrying capacity reduction of 2.6 percent.
	Long-term conversion of 4.5 acres of mature pinyon-juniper woodland habitat to shrub-grass character, with wildlife populations and community composition adjusting commensurate with remaining habitat.	Long-term conversion of from 54 to 127 woodland acres.	Long-term conversion of from 28 to 61 woodland acres.	Long-term conversion of from 186 to 406 woodland acres.
	Water consumption level of 88 acre-feet per year from Upper Colorado River Basin, ultimately reducing flow contributed to downstream endangered species fisheries.	Water consumption rate of 219 acre-feet per year.	Water consumption rate of 117 acre-feet per year.	Water consumption rate of 875 acre-feet per year.
	Riparian-wetland resources in Yellow Creek would remain unaffected.	No appreciable change in the extent or distribution of riparian-wetland resources in Yellow Creek expected.	Riparian-wetland resources in Yellow Creek would remain unaffected.	Substantial reduction in Yellow Creek's base flow would likely result in the loss of up to 1 acre of riparian-wetland habitat for 30-50 years. This loss is considered insignificant in a regional context.
Cultural Resources	4 known sites potentially impacted.	10 known sites potentially impacted.	7 known sites potentially impacted.	21 known sites potentially impacted.
	Potential destruction or loss of unknown sites from inadvertent disturbance due to construction, vandalism, or change in livestock grazing patterns.	Same	Same	Same

Note: the printed table has a spanning header "Alternatives" over the four alternative columns.

TABLE 2-2 (Continued)
SUMMARY OF IMPACTS

	Alternatives			
Resource	**No Action (Pilot Plant)**	**Proposed Action/125,000 TPY**	**50,000 TPY**	**500,000 TPY**
Paleontological Resources	No known sites impacted. Potential destruction or loss of unknown sites from inadvertent disturbance due to construction or vandalism.	3 known sites impacted.	No known sites impacted.	3 known sites impacted.
Lands and Realty	Potentially complicates the development of existing oil and gas leases and future oil shale leases through diminished surface occupancy possibilities for 2-year maximum project life.	May adversely influence development except for 30 years.	Same as proposed action.	Same as proposed action.
	Ancillary facility right-of-ways would establish undesignated utility corridors encouraging future utility right-of-way proposals.	Same	Same	Same
Recreation	Area would shift from semiprimitive motorized to rural recreation opportunity spectrum on 43 acres.	Same on 257 acres	Same on 118 acres	Same on 960 acres
Visual	Visual qualities downgraded from Class II to Class V.	Same	Same	Same
Social	Less than 1% population increase annually.	Same	Same	Same
Energy requirements (Btus x 10^{10}) per year/project life	19.58/39.16	43.84/1,315.00	17.52/525.60	119.40/3,582.00
Total acreage potentially disturbed over mine life	43	257	118	960

3. AFFECTED ENVIRONMENT

3. AFFECTED ENVIRONMENT

This section describes, by resource element, the existing environment of the area that would be affected by the analyzed alternatives. Certain critical resource elements such as wilderness values and wild and scenic rivers are not addressed in this document because they are not present within the existing affected environment.

3.1 Climate and Air Quality

3.1.1 Climate

The proposed project area is in the Piceance Basin of northwestern Colorado. The basin's climate is classified as semiarid continental. This type of climate is characterized by low relative humidity, sunny days and clear nights, low precipitation with high evaporation, and large diurnal temperature changes. Average maximum temperatures range from 45°F to 85°F during summer months and from 5°F to 35°F in the winter months. Annual precipitation ranges from 8 to 24 inches, approximately half of the moisture coming from scattered spring and late summer thundershowers. Snowfall amounts, which vary from 25 to 150 inches, are commonly redistributed by wind.

Although the regional wind flow is predominately from the southwest, the region's complex terrain induces strong localized wind flows or "drainage" winds in the late evening to mid-morning. The effect of these strong downslope drainage winds is to create air basins where local pollutant emissions may tend to accumulate. Air basins are areas with similar atmospheric flow, topographic influence, and general dispersion potential. Under stable atmospheric conditions, pollutants can collect and concentrate in an air basin until regional synoptic winds disperse the air in the basin. Generally, Piceance Creek downslope winds flow into the Craig air basin to the north along the White River (PEDCO Environmental, Inc. 1981).

The rate at which emitted pollutants will be dispersed in the atmosphere is related to the parameters of atmospheric stability and mixing height. Unstable conditions produce the best vertical dispersion, typically on summer afternoons. Neutral conditions reflect a breezy, well-mixed atmosphere and moderately good dispersion potential. Stable conditions exhibit downslope drainage, producing the least amount of dispersion. Temperature inversions may exist under stable conditions, trapping emitted pollutants within a layer of air close to the ground. In the Piceance Basin, moderate inversions are formed during summer evenings and dissipate at dawn. Winter inversions are stronger and last longer, typically 3 to 6 days (USDI, BLM 1976).

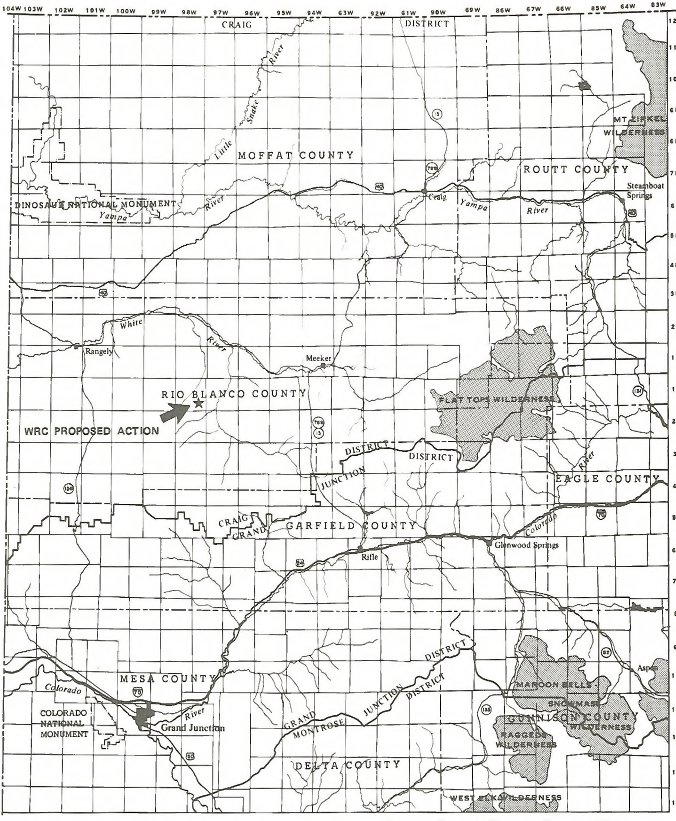
3.1.2 Air Quality

The proposed project area, and the entire Piceance Basin, currently have very good air quality. As in most undeveloped areas of the western United States, ambient levels of gaseous pollutants are usually near the lower limits of detection for available monitoring instruments. Exceptions to this are ozone (0_3) and total suspended particulates (TSP). Occasionally, moderately high concentrations of TSP and ozone have been measured; however, these are short in duration and seasonal in occurrence. Areas that may be affected by pollutant emissions from this project, and from other anticipated development in the basin, include the areas immediately surrounding the operation, distant areas (especially those with stringent air quality standards that could be impacted by long-range transport of pollutants) and population centers that may experience growth because of increased development. Both state and federal air quality standards applicable to this area are discussed in Appendix B "Air Quality Significance Criteria."

Class I areas closest to the project, and downwind from the predominate wind directions, are the Flat Tops and Mount Zirkel Wilderness areas. Other Class I areas of less concern because of distance or geographic orientation are the Maroon Bells, West Elk, and Ragged Wilderness areas, and the Colorado Category I areas of Dinosaur and Colorado National Monument. Map 3-1 shows the location of these Class I/Category I areas in relationship to the sodium project area.

On-site air quality and meteorological data are not available for the proposed project area. However, Rio Blanco Oil Shale Tract C-a, which is located about 6 miles to the southwest, has been collecting such data for 10 years. This data is valid for application to the Wolf Ridge Corporation (WRC) project area. Based on this data, existing concentrations are far below the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). Peak ozone levels at Tract C-a, and for the Piceance Basin as a whole, usually run about two-thirds of the NAAQS.

Moderately high TSP concentrations are routinely measured at Tract C-a, as well as at other sites across the Piceance Basin. Concentrations at or above the NAAQS have been measured at various times and places; however, these higher concentrations are both transitory and seasonal and can be expected to occur naturally in a windy, semiarid climate such as the Piceance Basin. Statistical analysis of data provides strong evidence that TSP comes from natural sources. Data indicate a definite seasonal and annual cycle with moderate levels in the summer and lower levels in the winter.



NW Colorado Showing Approximate Location of WRC Proposed Action in Relation to Areas Sensitive to Air Quality Impacts.

MAP 3-1

PSD regulations for Class I areas require a determination that the impacts of the proposed project will not adversely affect the Air Quality Related Values (AQRVs) of the area. AQRVs may include, but are not limited to: visibility, odors, and impacts to soils, water, flora and fauna, or geologic and cultural features. To date, most concern has centered on impacts to visibility and impacts attributable to increased acid deposition. Although no standards exist for visibility degradation and acid deposition, guidelines have been developed for judging the significance of predicted impacts.

In the study area, which is shown in Map 3-1, the only sensitive lands to acid deposition are those lakes and watersheds in the high mountains where soils and water do not have the capacity to buffer the acid precipitation. These areas are being inventoried and studied by researchers (Fox et al. 1983, Turk and Adams 1982). Preliminary results show that most of these sensitive lakes and watersheds have not yet had significant impacts from acid deposition.

For information on state and federal air quality standards, in addition to analysis guidelines and criteria, please see Appendix B "Air Quality Significance Criteria." For more detailed information on both climate and air quality, see the Affected Environment section in the C-a Offtract Lease Draft Environmental Impact Statement (EIS) (USDI, BLM 1985b).

3.2 Geology

3.2.1 Topography

The proposed solution mine would be located within the Piceance Basin, which is an elevated structural basin and a topographic basin. The topographic Piceance Basin is approximately 1,600 square miles. It is bound on the north by the White River, on the east by the Grand Hogback, on the south by the Roan Plateau, and on the west by Cathedral Bluffs and Calamity Ridge. Elevations range from about 5,200 feet at the northern edge to over 8,500 feet at the southern boundary. The topography is characterized by a series of nearly parallel north to northeasterly trending ridges and valleys.

The project area is on a moderately sloping upland known as Bar D Mesa, which is bordered by Piceance Creek to the east, Yellow Creek to the northwest, and Ryan Gulch to the south. The area is dissected by north to northeast trending ephemeral tributaries of Yellow Creek. Relatively flat, broad ridges and shallow gulches characterize the topography in this part of the Piceance Basin. Elevations range from 6,200 to 6,700 feet in the project area.

3.2.2 Stratigraphy

3.2.2.1 General

The general geology and mineral resources of the Piceance Basin have been described in the Piceance Basin Draft Resource Management Plan (RMP)/EIS (1984b) and in the Final Supplemental EIS for the Prototype Oil Shale Leasing Program (1983a).

The principal formations that may be affected by the Proposed Action are the Tertiary age Uinta and Green River formations. Please refer to Figure 3-1 for a general southwest to northeast structural cross section of the sodium lease area and Figure 3-1A for a general stratigraphic column of the Uinta and upper Green River formations of the basin. The Uinta Formation, which is the uppermost stratigraphic unit, consists of deltaic and fluvial sandstones and siltstones deposited during Eocene time.

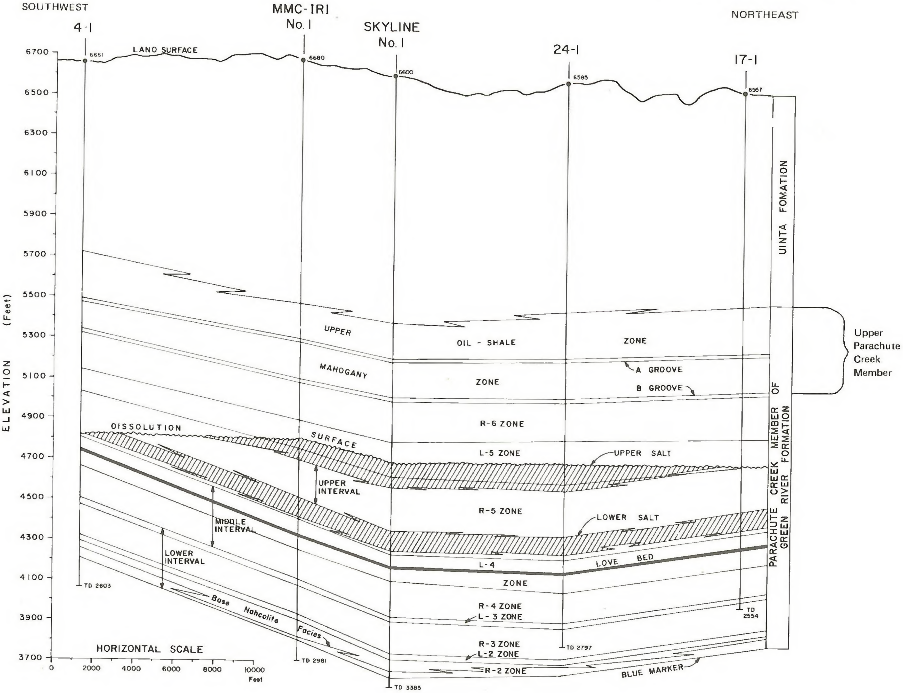
The Uinta Formation contains no economic mineral resources and is considered as overburden to the oil shale and sodium bearing members of the Green River Formation. The Green River Formation lies immediately below the Uinta and consists of a thick sequence of alternating lean and rich oil shale zones interbedded in certain areas with saline minerals, principally nahcolite and halite; dawsonite is finely disseminated and dispersed throughout the section. Going from the rim of the basin to the center, the rich oil shale zones, designated from top to bottom R-8 to R-1, tend to thicken, and the lean zones, designated L-7 to L-1, tend to thin (Figures 3-1 and 3-1A).

The Saline Zone, which contains abundant quantities of oil shale, nahcolite, halite, and disseminated dawsonite is located in the north central part of the basin, in the lower part of the Parachute Creek Member of the Green River Formation. Large portions of the original saline deposit have been dissolved and leached by groundwater. The contact between this leached zone and the underlying remaining Saline Zone is called the dissolution surface (Figures 3-1 and 3-1A).

A thick sequence of sedimentary rocks occurs beneath the Green River Formation. These rocks are prospectively valuable for oil, gas and coal, mostly at depths exceeding 3,000 feet.

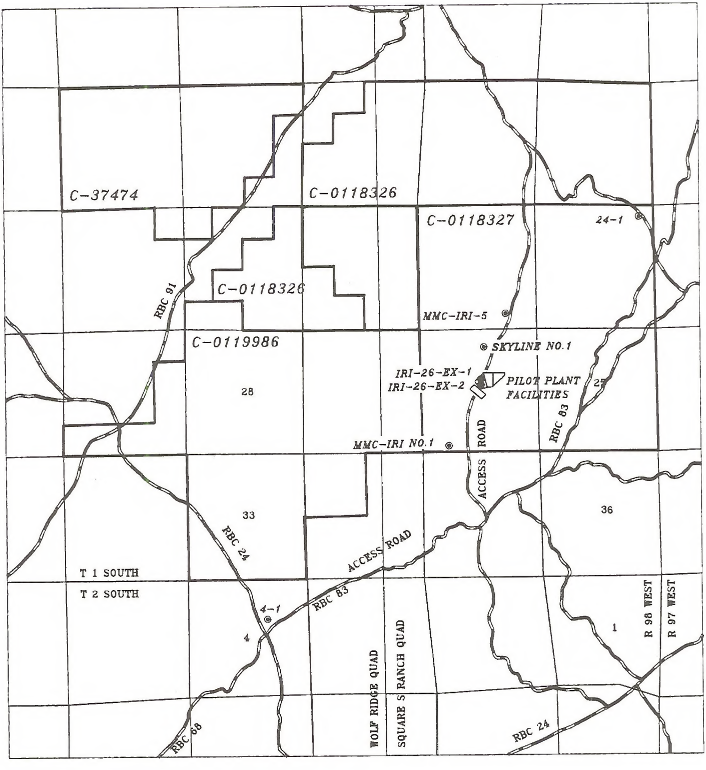
3.2.2.2 Project Area

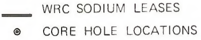
The Uinta Formation consists of four intervals of siltstone and sandstone interbedded with several tongues of the Green River Formation. Average thickness of the Uinta Formation and its tongues is approximately 1,150 feet in the lease area. The contact of the Uinta Formation with the Parachute Creek Member of the Green River Formation is usually at a depth of 1,000 to 1,200 feet. The average thickness of the Parachute Creek Member, the uppermost section of the Green River Formation, is approximately 1,750 feet. The R-8 oil shale zone, A-Groove, Mahogany Zone,

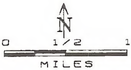


Structural Cross Section SW - NE Through the Wolf Ridge Corp. Lease Area.
See Map 3 - 1A For Corehole Locations

FIGURE 3-1







CORE HOLE LOCATION MAP

MAP 3-1A

B-Groove, R-6, and part of the L-5 oil shale zone constitutes the "leached zone" (Daub et al. 1985). Within this sequence, the Mahogany Zone is the most economically important interval, averaging 175 feet in thickness and having an average grade of 29 gallons per ton (gpt) of shale oil.

The leached zone ranges from 590 to 672 feet in thickness within the lease area. From the lower Mahogany to the dissolution surface, the zone consists of rich to lean oil shales that are more or less fractured and collapse breccia, rubble zones, and cavities (voids) created by the dissolution of sodium minerals. Because less nahcolite was present for leaching in most of the Mahogany and R-8 zones, these secondary effects are less pronounced there.

The lowest section of the Parachute Creek Member, the Saline Zone, averages approximately 1,000 feet in thickness. It is bounded at the top by the dissolution surface and includes all or part of the L-5, the R-5 and R-2 zones, and all of the L-4, R-4, L-3, R-3, and L-2 zones (Figures 3-1 and 3-1A).

The target zone of the proposed plan is the Boies Bed, which constitutes the lower section of the L-5 Zone (designated the L-5A or Boies Bed). In the lease area, the top of the Boies Bed is generally 100 feet or less below dissolution surface.

The Boies Bed is composed of three different facies in the lease area. The proposed project is located in the nahcolite facies where the Boies Bed averages 30 feet in thickness and 80-85 percent granular nahcolite by weight. This portion of the Boies Bed is of limited extent in the lease area. To the south and west of the project area, groundwater movement has totally removed the bed. To the north and east of the project area, the Boies Bed enters the transition facies where it is composed of nahcolite and nahcolitic halite. The nahcolitic halite facies extends even farther to the north and east, where the Boies Bed is composed entirely of nahcolitic halite.

The L-5B and C beds, which consist of disseminated nahcolitic oil shale approximately 20 feet in thickness, lie immediately above the Boies Bed. The L-5E Bed lies immediately above these beds and is composed of saline minerals very similar in quality to that of the Boies Bed. This bed averages approximately 10 feet in thickness in the project area, becoming thinner to the southwest and thicker to the northeast. Three thin beds (2-3 feet thick) of nearly pure kerogen occur above the Boies Bed in the L-5 Zone. These beds are known as the "rubber beds" because they have elastic properties.

The remainder of the Saline Zone below the Boies Bed consists of the R-5 through R-2 zones (in descending order R-5, L-4, R-4, L-3, R-3, L-2, R-2) (Figures 3-1 and 3-1A). These zones contain varying thicknesses and grades of nahcolitic oil shale, disseminated and bedded nahcolite, halite, and disseminated dawsonite. This interval contains the R-4 Zone, which in this part of the basin is the richest oil shale zone in the Parachute Creek Member. In the lease area, this zone averages 158 feet in thickness, 33 gpt shale oil, 23 weight percent nahcolite, and 9 weight percent dawsonite.

3.2.3 Rock Quality

Rock quality of the Saline Zone is generally considered to be quite good, with recovery of oil shale and/or sodium minerals possible by underground mining or in situ methods. The beds lying above the Boies Bed and below the dissolution surface (L-5B, C, and E beds) are very competent and will assist in providing structural stability in those areas overlying the proposed solution cavities. In addition, there is a 10-foot interval of competent lean oil shale extending above the dissolution surface (within the leached zone) that should also provide some structural support.

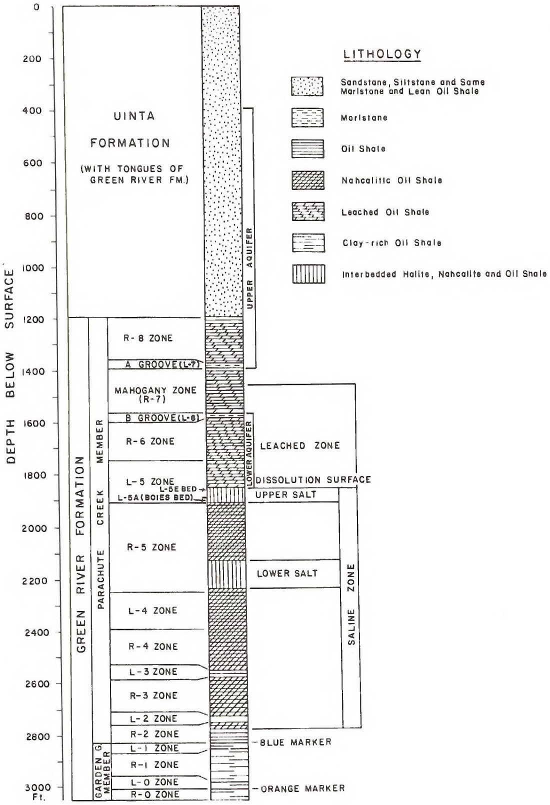
That portion of the leached zone up to the lower Mahogany Zone consists of rock of generally very poor quality. The dissolution of the sodium minerals by groundwater has resulted in collapse and fractures throughout this zone. Based on core studies, recovery of remaining oil shales by conventional methods is not considered feasible. Above the B-Groove, the interval of interest is the Mahogany oil shale zone.

The Mahogany Zone is fractured in this part of the basin because of dissolution of nahcolite and movement caused by collapse of intervals within the leached zone. However, an interval in the upper Mahogany Zone, about 40-60 feet in thickness, has been identified that could be suitable for conventional room and pillar mining.

3.3 Mineral Resources

3.3.1 Fluid Minerals

The federal government has leased 100 percent of the oil and gas mineral estate underlying WRC's sodium lease tracts with the following six leases: C-24105, C-24888, C-25619, C-25908, C-39812, and C-40441. Although no producing oil or gas wells exist on the project area, it is underlain by potential oil and gas producing formations. These formations, which lie beneath the proposed mining zone, consist of the Tertiary Douglas Creek Member of the Green River Formation and Wasatch Formation, the Cretaceous Mesaverde Group, Mancos Shale and Dakota Formation, and the Jurassic Morrison Formation.



General Stratigraphic Column of Uinta Formation and Upper Green River Formation
FIGURE 3-1A

3.3.2 Solid Minerals

No minerals of economic significance are known to occur within the Uinta Formation. The Mahogany Zone contains an estimated 350,000 barrels per acre of shale oil in the project area over its entire thickness. The interval identified for mining in the previous section contains approximately 94,000 barrels per acre of shale oil. Although the leached zone below the Mahogany Zone contains significant quantities of oil shale, the dissolution of the sodium minerals and resultant poor rock quality has rendered the recovery of minerals from this zone unfeasible by existing recovery methods. Within the project area, the Boies Bed is estimated to contain 66,000 tons/acre of nahcolite, and the L-5E Bed to contain approximately 51,000 tons/acre of nahcolite. Estimated in place resources within the remainder of the Saline Zone beneath the Boies Bed (R-5 through R-2 zones) are 1,500,000 barrels per acre of shale oil, 724,000 tons per acre of nahcolite, and 159,000 tons per acre of dawsonite.

3.3.3 Other Minerals

3.3.3.1 Locatable Minerals

All of WRC's sodium leases are under U.S. Geological Survey (USGS) oil shale classification C-33196 and Public Land Order 4522. Because of these actions, these lands have been withdrawn from operation under the General Mining Law of 1872. No known economic deposits of locatable minerals occur within the sodium lease tracts. There are no apparent conflicts between the Proposed Action and development of locatable minerals.

3.3.3.2 Salable Minerals

Limited amounts of salable minerals are available within the sodium lease tract. These include sand, gravel, and sandstone. The sand and gravel are found in Quaternary alluvial deposits, and the sandstone is from the Tertiary Uinta Formation. This material is used for road construction and maintenance in this area of the basin. Neither the Proposed Action nor any of the alternatives will affect the development of salable minerals.

3.4 Water Resources

3.4.1 Surface Water

3.4.1.1 Surface Water Quantity

The sodium leases lie within the Piceance hydrologic basin. Piceance and Yellow creeks, which both drain into the White River, are the principal drainages within this basin.

Surface runoff in the Piceance Basin is from snowmelt during spring months and high-intensity summer thunderstorms. Most annual flow from Piceance and Yellow creeks is sustained by groundwater discharge. The groundwater discharge to surface flows has been estimated to be 80 percent of the total flow of these creeks (Weeks et al. 1974).

Recharge to the groundwater system is principally from snowmelt. Snow accumulates during the winter months at elevations in excess of 7,000 feet. Snowmelt produces a period of high streamflow during the spring (Weeks et al. 1974). Table 3-1 summarizes the principal characteristics of the two streams.

TABLE 3-1

CHARACTERISTICS OF PICEANCE AND YELLOW CREEKS

Characteristics	Piceance Creek At White River	Yellow Creek
Drainage area (square miles)	652	262
Average annual discharge (acre ft)	24,270.00 [c]	1,340.00 [a]
Maximum daily discharge (cfs)	525.00 [c]	500.00 [a]
Minimum daily discharge (cfs)	0.50 [c]	0.00 [a]
Average daily discharge (cfs)	33.50 [c]	1.85 [a]
Maximum instantaneous discharge (cfs)	628.00 [c]	6,800.00 [a]
Sediment discharge (tons)	56,115.00 [b]	12,495.00 [b]
Maximum daily sediment discharge (tons/day)	6,090.00 [c]	290,000.00 [a]
Minimum daily sediment discharge (tons/day)	0.10 [c]	0.00 [a]
Maximum TDS (mg/l)	1,200.00 [d]	2,090.00 [b]
Minimum TDS (mg/l)	670.00 [d]	489.00 [b]

[a] For the period 1972-1980.

[b] 1980 water year.

[c] October 1970 to September 1984.

[d] 1984 water year.

Source: USGS Water Resource Data

Conversion: cfs × 1.9835 = acre-feet per day.

Different periods of record are available for the two streams; therefore, the numbers presented in Table 3-1 are not directly comparable. The flow from Yellow Creek is more erratic than the flow from Piceance Creek, and the majority of the surface flow leaving the Piceance Basin comes from Piceance Creek.

The drainage system within the sodium lease area is characterized by a series of intermittent and ephemeral streams; rolling uplands; steep valley sideslopes; and short, narrow, relatively flat valley bottoms near Yellow Creek. Steep slopes, coupled with intense storms, have resulted in localized mass-wasting of land forms along the upper and middle channel reaches, leading to the accumulation of alluvial fill and the creation of alluvial fans at the confluence of drainages within Yellow Creek. In many sections, the channel bottom is on sandstone and shale bedrock. The channel gradient of the tributary drainages throughout the lease area averages 2.5 percent.

The sodium lease tract area drains into two streams, Yellow Creek and Piceance Creek (Map 3-2). The majority of the area (96.5 percent) is drained by the Yellow Creek watershed, and the remainder (3.5 percent) is drained by the upper portion of Horse Draw, a tributary to Piceance Creek. Horse Draw is very steep, small in size, and in the extreme southeastern portion of the lease tract. Surface runoff to this drainage basin is not expected to be affected by lease operations.

Total drainage area to Yellow Creek within the lease area is 13.1 square miles, or about 5 percent of the 262 square mile basin area of Yellow Creek. Three unnamed ephemeral tributaries to Yellow Creek drain the proposed mine site. Flow in Yellow Creek is intermittent in much of its middle reach and perennial in some upstream reaches and in the lowest several miles of the stream. Flow is dependent on annual precipitation, snowpack depths, thickness of the alluvium, and for the past several years, on mine water discharge from Oil Shale Tract C-a. Average daily discharge from Yellow Creek near the confluence with the White River is 1.81 cubic feet per second (cfs), or about 1,380 acre-feet per year. The gauge at the mouth of Yellow Creek was discontinued in 1982. Only 10 years of discharge records are available. Extremes for the period of record include several no-flow days and a maximum discharge of 6,800 cfs on September 7, 1978. This was a flash flood that carried a sediment load of 290,000 tons. The high flow followed an unusually intense thunderstorm, most of which fell only in the downstream one-third of the Yellow Creek drainage. The average suspended sediment load in Yellow Creek at White River is only about 12,000 tons per year. The 13.1 square mile drainage area within the leases could generate a 100-year peak-flow of 80 cfs (Kircher, Choquette and Richter 1985). This would be the 100-year storm contribution from the drianage areas iwthin the leases to Yellow Creek.

No springs occur in the lease area or within 1 mile of the lease boundaries.

3.4.1.2 Surface Water Quality

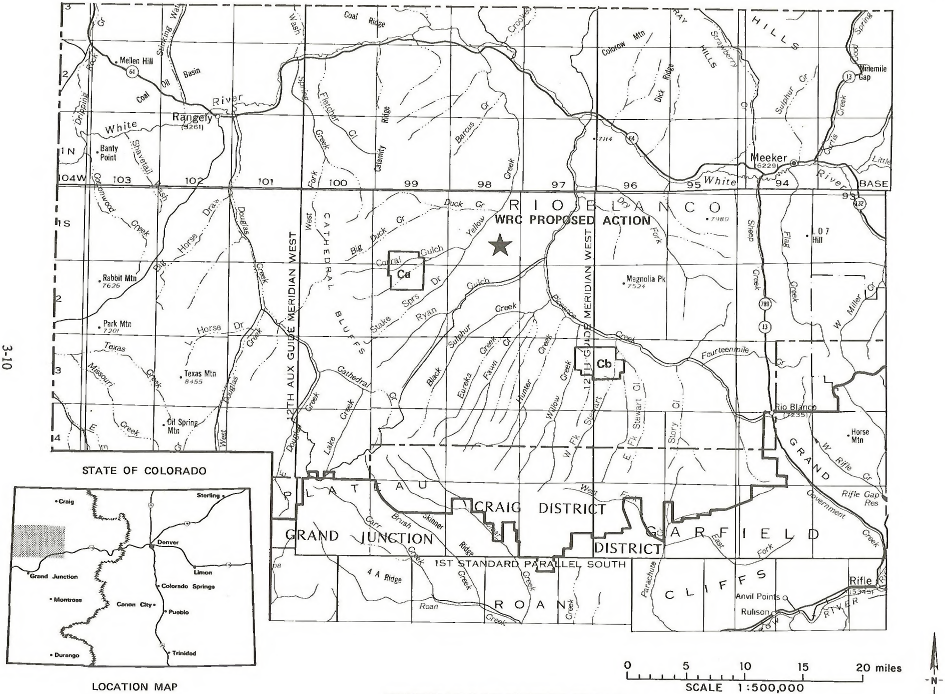
There are no site-specific water quality data for the ephemeral tributary drainages on the lease tract area. Sparse data in similar areas suggest that runoff probably contains a few hundred milligrams per liter (mg/l) total dissolved solids (TDS). A recent report by Tobin et al. (1985) and water quality analyses published by the U.S. Geological Survey indicate that the surface waters of Yellow Creek and its tributaries can be classified as a mixed bicarbonate type in the upper reaches, grading to a sodium bicarbonate type in the lower reaches. This change in water quality is thought to be caused by groundwater discharge from the Uinta and Green River formations (Weeks et al. 1974).

Water temperatures in Yellow Creek range from summer highs in the 86°F to 95°F range, to 32°F during the winter months. Specific conductance, which is related to TDS content, typically is in the range of 800-1,500 uhmos (550-1,000 mg/l TDS) in the upper reaches, and 3,000-4,000 uhmos (2,000-2,500 mg/l TDS) at the mouth of the creek. Dissolved solid concentrations typically decrease during the spring high-flow period because of dilution from snowmelt runoff. During low-flow periods, the concentrations increase because of irrigation return flow and groundwater discharge. Piceance Creek has similar water quality; it also shows an increase in TDS in a downstream direction, however, TDS levels are generally less in Piceance Creek than in Yellow Creek (Weeks et al. 1974).

3.4.2 Groundwater

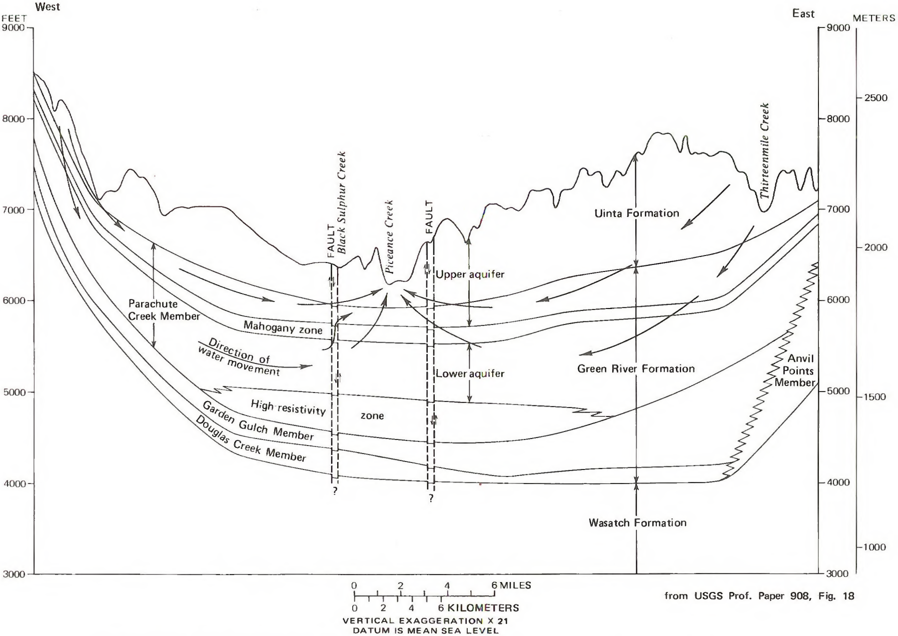
The principal usable bedrock aquifers that occur in the basin are commonly referred to as the upper and lower aquifers of the Uinta and Green River formations. Figure 3-2 shows a generalized geohydrologic cross section of the Piceance Basin aquifer system. These aquifers are recharged at the higher elevations on the west, south, and eastern margins of the basin. Flow is generally to the north-central part of the basin (Weeks et al. 1974). The aquifers discharge to Piceance Creek and Yellow Creek which discharge into the White River. The Piceance Basin groundwater system probably does not discharge directly to the White River, because the White River flows on alluvium which rests on the Wasatch Formation, which is hydrologically isolated from the Green River Formation within the basin. For this analysis, it is assumed that the groundwater transport of salt is a closed system in the Piceance Basin, with all inputs restricted to the basin and out flow by way of discharge to Piceance and Yellow creeks.

Three aquifer systems occur within the basin: the alluvial, upper, and lower aquifers. These aquifers are hydraulically connected with one another but can be considered separate reservoirs. The degree and extent of hydraulic connections are not yet fully understood and probably vary considerably by location within the basin. Most of the stream valleys in the basin contain recent alluvial material, which is



LOCATION OF SURFACE WATER DRAINAGES

MAP 3-2



from USGS Prof. Paper 908, Fig. 18

Generalized geohydrologic section through the Piceance basin showing relation of the aquifers to the Green River and Uinta Formations. The arrows show diagrammatically the direction of ground water flow. WRC lease area is approximately 5 miles north of this cross section.

FIGURE 3-2

saturated in certain areas. This saturated zone is the alluvial aquifer, which is generally unconfined and varies greatly in size and yield from one stream valley to another. The major alluvial aquifers are restricted to stream valleys and do not occur on uplands.

The upper and lower aquifers are bedrock aquifers, within the Uinta Formation and the Parachute Creek Member of the Green River Formation. These two aquifers are generally separated by the Mahogany Zone of the Parachute Creek Member of the Green River Formation. The Mahogany Zone is probably a semiconfining layer between the two aquifers, which allows some communication between the two aquifers through secondary porosity developed in fractures in the Mahogany Zone. Because of its high kerogen content, the rock is less brittle; therefore, the Mahogany Zone is less susceptible to fracturing than is either the upper or lower aquifers. In some places in the basin the Mahogany Zone is not fractured and allows very little communication between the aquifers. In other areas substantial communication takes place (Weeks et al. 1974; Robson and Saulnier 1981; Daub, Weston and Rosar 1985; Wright Water Engineers and Daub Associates 1985; Weston 1984; Industrial Resources, Inc. 1984).

The two bedrock aquifers are generally confined or artesian. This means that the water level of a well in the water bearing zones will be higher than the water table. The relative degree of communication between the aquifer systems can be inferred by the difference in the hydraulic head (water levels) of the two aquifers. If there is a great deal of communication between the two aquifers, one would expect little difference in the hydraulic head between the aquifers. There are few places in the basin where the head difference exceeds 200 feet; generally, the difference in head does not exceed 100 feet (Weeks et al. 1974). The presence of faulting or fracturing in confining layers that separate aquifers can be indicated by the observed difference in hydraulic head of the two aquifers.

The bedrock aquifers discharge to the surface water directly from springs or indirectly through discharge to the alluvial aquifer. The alluvial aquifer then discharges to the surface.

The aquifer systems probably hold between 6.5 and 22 million acre-feet of water in storage at any one time (Robson and Saulnier 1981). Annual discharge from the aquifers is about 18,000 acre-feet per year. The saturated thickness of the upper and lower aquifers ranges from 1,300 to 1,500 feet. The base of the lower aquifer lies on beds of salt and oil shale, which make up the saline or high resistivity zone of the Parachute Creek Member of the Green River Formation, and is called the dissolution surface. Dissolution of some of these salt deposits is an active process in the basin.

Water occurs in the upper and lower aquifers because of secondary porosity that developed after the deposition of the rock strata. In the Piceance Basin, secondary porosity is created principally by fracturing and by dissolution of the soluble salt nodules and layers within the oil shale. The secondary porosity developed in the solution features could result in high rates of water movement through the zone; however, the irregularity and localized occurrence of the solution features also accounts for some wide variations in permeability.

A perched aquifer which is in the Uinta Formation, lies above the upper aquifer (Weston 1985). The Uinta Formation generally has very low porosity because of the filling of pores in the rock with natural cement. Therefore, the perched aquifer is probably discontinuous and only a minor component of the groundwater system regionally.

The hydraulic head difference between the upper and lower aquifers ranges from 0 to 100 feet within the sodium leases. The difference in hydraulic head at the proposed well field ranges between 1 and 10 feet. Approximately the lower third of the Mahogany Zone within the lease area has dissolution features that now contain and yield water. At least 1,000 acres of the dissolution surface within the sodium leases is in contact with salt. This is a minimum amount because it only represents the acreage of the truncation zone of the Boies Bed; it does not measure the contact of the salt of the L-5E Bed with the dissolution surface. Basin wide, there may be as many as 20,000 acres of the dissolution surface which are in direct contact with salt.

Pump tests done by the Multi-Minerals Corporation and the USGS in 1981 in the eastern portion of the leases indicate that the direction of greatest permeability of the upper aquifer is to the northeast and the lower aquifer is to the northwest (Weston 1984). Very little data are available that clearly describe the rate of flow within the aquifer system within the sodium leases. Preliminary indications are that the upper aquifer could flow at about 150 feet per year and that the lower aquifer could flow at about 90 feet per year.

The flow in the lower aquifer is toward a sink that is located in the northwestern portion of the lease area. The characteristics of any flow out of this sink are unknown; however, high density fluids (for example brines) could collect in this basin.

The perched aquifer in the Uinta Formation does exist in the area of the leases but is discontinuous (Weston 1985).

There is no significant area of alluvial aquifers on the sodium leases.

3.4.3 Groundwater Quality

Groundwater in the alluvial aquifer is classified as a sodium bicarbonate type. Concentrations of dissolved solids range from 470 mg/l to a local high of 6,720 mg/l. Average levels of dissolved solids in the alluvium are nearer to 1,750 mg/l over the entire basin (Weeks and Welder 1974). Higher TDS levels occur downstream toward the White River; they are attributed mainly to irrigation water returns, groundwater inflow from bedrock aquifers, and the concentrating effect of evapotranspiration (Weeks et al. 1974).

Much of the groundwater in the upper aquifer system is classified as a sodium bicarbonate type with sulfate locally as a major anion. Generally, concentrations of dissolved solids increase with aquifer depth and in a northerly direction. TDS contents range from 400 to 2,000 mg/l. This increase may be related to the solution of minerals and to groundwater movement from the lower to the upper aquifer (Weeks et al. 1974). Calcium, magnesium, and sulfate concentrations are generally greater in the upper aquifer than in the lower aquifer. Sodium, bicarbonate, and fluoride are higher in the lower aquifer.

Total dissolved solid concentrations of the lower aquifer vary from about 500 mg/l to nearly 40,000 mg/l and are dependent on depth and location. Dissolved solid concentrations of 63,000 mg/l have been reported from a sample obtained during drilling through salt deposits of the high resistivity zone (Weeks et al. 1974). Limited data indicate that the quality of water deteriorates as it approaches the dissolution surface (Welder and Saulnier 1978). The lower aquifer water is generally classified as a sodium bicarbonate type.

Groundwater sampled on and near the sodium lease tracts indicates that the upper aquifer water tends to be a sodium-sulfate-bicarbonate type and typically contains 500 to 600 mg/l TDS. Compared to the lower aquifer, it contains lower concentrations of TDS, fluoride, and chloride, and elevated concentrations of calcium, magnesium, and sulfate.

The upper aquifer within the sodium lease tracts does not always meet the proposed Colorado groundwater quality standards for drinking water because it is too high in fluorideand pH. Iron levels are also marginal. It does not meet the standard for irrigation because of high pH, molybdenum, and fluoride. The lower aquifer does not meet the proposed standard for drinking water because of high concentrations of fluoride and because it is marginal for pH. The lower aquifer does not meet the standards for irrigation because of excessive molybdenum and fluoride, and it is marginal for pH. Table 3-2 shows some selected water quality parameters for the lease area and the proposed standards. This table is based on sparse water quality data from only a few wells. Samples have only been taken for a very short period of time; therefore, it is not possible to show how groundwater quality on the leases might fluctuate with time. A monitor well completed 50 feet above the dissolution surface showed a range in TDS from 2,600 mg/l to 9,000 mg/l over a 4-month period.

3.4.4 Water Uses and Water Rights

Presently, the major water use in the Piceance Basin is irrigation. About 4,400 acres are irrigated annually, diverting about 33,790 acre-feet per year in the Piceance Basin (Kuiper et al. 1978). This number exceeds annual stream flow because of the large amount of reuse of irrigation water. Livestock, wildlife, and limited domestic uses are the only other water uses in the basin. There is a well about 2 miles south of

TABLE 3-2

WATER QUALITY PARAMETERS FOR THE SODIUM LEASE AREA AND STATE STANDARDS

Parameter	Upper Aquifer [a]	Lower Aquifer [a]	Colorado Human Health Standard	Colorado Irrigation Standard
pH (units)	8.6 to 8.7	8.5	6.5-8.5	6.5-8.5
Fluoride (mg/l)	1.4 to 20.5	23.5	1.6	2.0
Iron (mg/l)	0.26	0.12	0.3	5.0
Molybdenum (mg/l)	0.019	0.021	[b]	0.01
			All Waters	
			Background	Limit
TDS (mg/l)	855	2,210	0-500	Not to exceed 500
			501-10,000	Not to exceed 25% incr.
			10,000 or greater	No limit

---

[a] Samples collected in August 1984 from well IRI-PW-2 (Industrial Resources, Inc. 1984). Upper aquifer was also sampled in 1981 at the site of the MMC/USGS pump test about one mile from the proposed well field (Weston 1984)

[b] No standard proposed.

the southernmost lease boundary that is used for wildlife and livestock watering.

Water rights are held by the existing water users. A significant number of industrial water rights have been obtained by a wide variety of people because of the projected need for large amounts of water for the development of oil shale. Industrial Resources, Inc., holds several water right allocations on and off the leases in the form of groundwater, storage, and flow rights. All of these rights are associated with the development of Wolf Ridge Corporation's leases.

3.4.5 Alluvial Valley Floors and Floodplains

Although the exact extent of alluvial valley floors within the sodium leases has not been determined, probably very few areas would meet the definition of an alluvial valley floor.

Floodplains within the lease area occur along portions of Stake Springs Draw, Corral Gulch, Yellow Creek, and on a small unnamed tributary that flows into Yellow Creek. The potential for flash flooding exists throughout the area, resulting from snowmelt and high intensity localized thunderstorms.

3.5 Soils

The soils on the project area were mapped by the Soil Conservation Service in an Order III soil survey of Rio Blanco County. An Order III survey mainly delineates soil associations, complexes and consociations with a minimum size map unit of about 6 acres. Complete detailed maps and mapping unit descriptions exist in a published survey by (United States Department of Agriculture, (SCS 1982a). In addition, VTN Consultants conducted an intensive study of soil characteristic on 1,620 acres, which covered a small part of the project area in sodium leases C-0118327 and C-0119986 (WRC Mine Plan 1984). Soil mapping units occurring in the WRC sodium leases are listed in Table 3-3, along with respective acreages. The physical characteristics of the soils are listed in Table 3-4. The soil mapping unit delineations are shown in Map 3-3.

The soil resource within the project area is extremely variable, depending on the soil parent materials, vegetation, elevation, slope, aspect, past and present climate, and time in place. The soils within the project area are cold, with a mean annual soil temperature of less than 47°F and are dry for a large portion of the time when soil temperatures are warm enough for plant growth. The soils throughout the project area are generally alkaline or saline, because the precipitation is insufficient to leach the salts (primarily calcium, sodium, and magnesium) from the soil. The pH values of the soils range from near neutral (6.9) to moderately alkaline (8.6), which is typical for areas with low annual precipitation (normally less than 16 inches per year).

TABLE 3-3

SOIL MAPPING UNITS OCCURRING ON THE SODIUM LEASE AREA

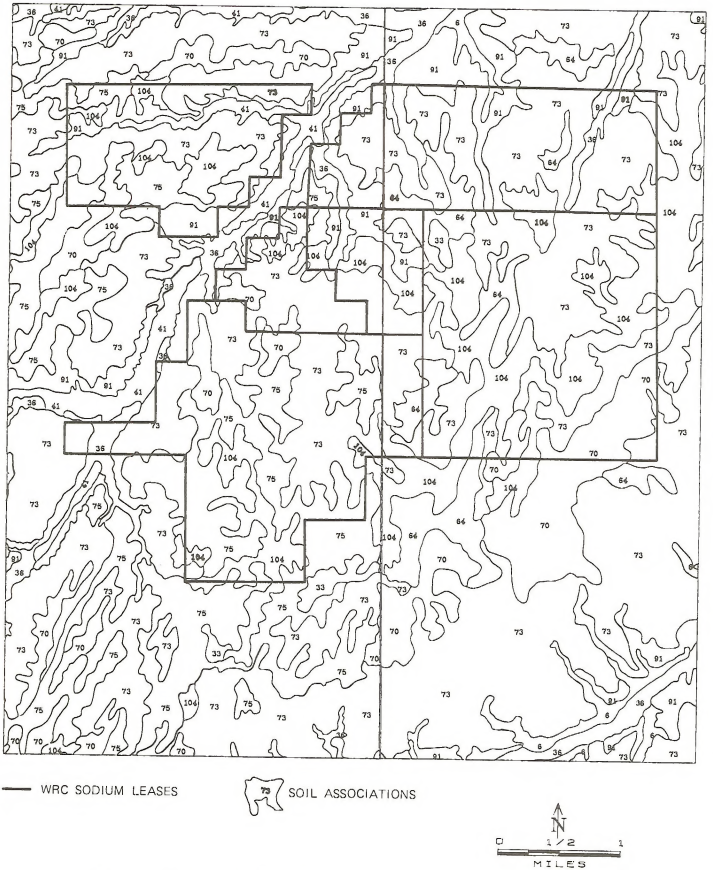
Unit Symbol	Soil Mapping Unit Name	Slope Percent	Acreage
6	Barcus	2-8	35
33	Forelle	3-8	35
36	Glendive fine sandy loam	2-4	167
41	Havre loam	0-4	87
64	Piceance fine sandy loam	5-15	896
70	Redcreek-Rentsac complex	5-30	501
73	Rentsac channery loam	5-50	4,050
75	Rentsac-Piceance complex	2-30	105
91	Torriorthents-Rockoutcrop complex	15-90	678
104	Yamac loam	2-15	1,806
	Total Acres		8,360

Note: This table represents an approximation of actual lease acreage.

TABLE 3-4

SOIL MAPPING UNITS OCCURRING ON THE SODIUM LEASE AREA AND THEIR PHYSICAL CHARACTERISTICS

Soil Mapping Unit Symbol	Soil Surface		Subsoil Total		Permeability	Available Water Holding Capacity	Rooting Depth	Rate of Surface Runoff	Water Erosion Hazard
	Texture	Depth	Texture	Depth					
6	Channery loam	6″	Very channery loam/ fine sand	60″+	Rapid	Low	60″+	Slow	Moderate
33	Loam	4″	Loam to clay loam	60″+	Moderate	High	60″+	Medium	Moderate
36	Fine sandy loam	6″	Loam to fine sandy loam	60″+	Mod. rapid	Moderate	60″+	Slow	Slight
41	Loam	21″	Loam and silty clay loam	60″+	Moderate	High	60″+	Medium	Slight
64	Fine sandy loam	4″	Loam to channery loam	30″	Moderate	Mod. low	20-40″	Slow to med.	Mod./high
70	Sandy loam	4″	Channery loam	16″	Mod. rapid	Very low	10-20″	Medium	Mod. to high
73	Channery loam	5″	Extremely channery loam	16″	Mod. rapid	Very low	10-20″	Rapid	Very high
75	Channery loam	5″	Very channery loam	16″	Mod. rapid	Very low	10-20″	Rapid	Very high
91	Channery loam	3″	Very channery loam	16″	Moderate	Very low	10-20″	Very rapid	Very high
104	Loam	4″	Loam	60″+	Moderate	Mod. to high	60″+	Medium	Slight to mod.



SOIL ASSOCIATIONS – WRC LEASES

MAP 3-3

Salinity, pH, and the sodium adsorption ratio significantly increase with soil profile depth (WRC Mine Plan 1984). Trace element concentrations are generally constant throughout the surface and subsurface soils.

The three dominant soil mapping units that will be affected by the proposed project are Piceance fine sandy loam, 5 to 15 percent slopes; Rentsac channery loam, 5 to 50 percent slopes; and Yamac loam, 2 to 15 percent slopes. The major characteristics for each of these soils is described below.

The Piceance soil is moderately deep (about 30 inches), well drained, and is on uplands and broad ridge tops associated with sagebrush parks. The textures are fine sandy loam on the surface and loam to channery loam in the subsoil. It is characterized by moderate permeability, moderately low available water-holding capacity, slow to moderate rate of surface runoff, and moderate to high water erosion hazard.

The Rentsac soil is shallow (about 16 inches), well drained, and located on ridges, foothills, and sideslopes under pinyon-juniper woodlands. It is coarse textured and has a large content of coarse fragments throughout the profile. It is characterized by moderately rapid permeability and very low available water-holding capacity. Runoff is rapid, and the hazard of water erosion is very high.

The Yamac soil is deep (about 60 inches), well drained, and exists on rolling uplands, terraces, and fans. It has a loam texture throughout the profile, and is characterized by moderate permeability and moderate to high available water-holding capacity. Runoff is medium, and the hazard of water erosion is slight to moderate.

The main limitations for reclamation of disturbances in the project area include: short growing seasons, low annual precipitation, low to moderate available water-holding capacity, shallow depth to bedrock, high wind and water erosion hazard, and localized areas of steep slopes that restrict accessibility. There are also small areas that have high salinity levels which are restrictive to plant establishment.

3.5.1 Prime and Unique Farmlands and Statewide Important Farmlands

There are no prime farmlands of national importance in or adjacent to the proposed project area. There are irrigated farmlands approximately 5 miles downstream from the project area, which are considered to be of statewide importance (USDA, SCS and CSU 1979).

The sodium lease tracts contain small portions of soil mapping units 36 (Glendive fine sandy loam) and 41 (Havre loam). These soils are potential prime farmlands when irrigated (SCS 1982b). However, there is little probability that these areas will ever be cultivated.

3.6 Vegetation

Within the project area there are four major vegetative types: high-elevation pinyon-juniper, mid-elevation big sagebrush, low-elevation big sagebrush, and hillside bunchgrass. Map 3-4 shows these major vegetation types within the sodium lease tract area. Discussion of these vegetative types emphasizes existing species composition, condition and trend, and productivity. Maps depicting the major vegetative types and methodology for determination of condition may be found in the Proposed Grazing Management Program for the White River Resource Area, Draft EIS (USDI, BLM 1980). The following descriptions are based on the phyto-edaphic system of land classification as described in the Phyto-Edaphic Classification of the Piceance Basin (Tiedeman and Terwilliger 1978). This system uses soil and vegetation relationships to classify ecosystems. Please see Appendix C for tabular descriptions of each affected vegetative type in terms of condition and trend by alternative.

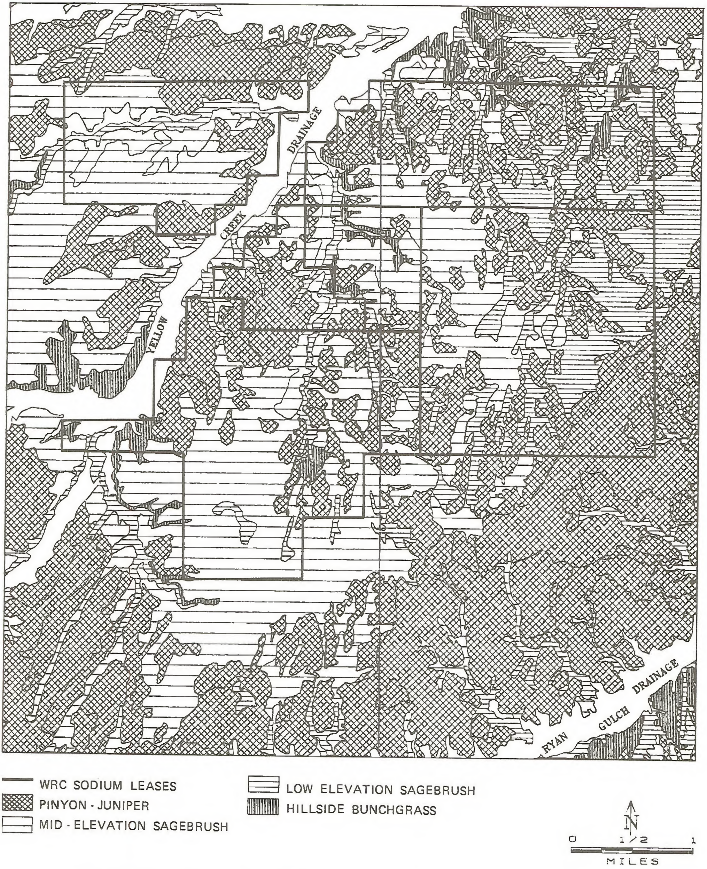
3.6.1 High-Elevation Pinyon-Juniper Type

The high-elevation pinyon-juniper type is characterized by an overstory of low growing pinyon and Utah juniper. Elevation ranges from 6,000 to 7,000 feet on slopes to 30 percent. Associated understory species include big sagebrush, mountain mahogany, western wheatgrass, needle-and-thread grass, and arrowleaf balsam root. Production is highly variable; the sparse stands of pinyon-juniper have greater herbaceous production than the closed stands. Herbaceous weight biomass ranges from virtually no production to 700 lbs/acre.

All pinyon-juniper acreage is considered low-quality timber sale areas. The proposed alternatives and associated ancillary facilities would affect an insignificant number of acres of commercial woodland.

3.6.2 Mid-Elevation Big Sagebrush Type

The mid-elevation big sagebrush vegetative type is characterized by dominant sagebrush cover averaging greater than 18 inches in height. Less than 40 percent of the area is bare ground. Elevation ranges from 6,000 to 7,700 feet, with slopes ranging from 0-20 percent with variable aspects. Soils tend to be deeper than 20 inches. Associated understory species include Douglas rabbitbrush, western wheatgrass, Indian ricegrass, needle-and-thread grass, and scarlet globemallow. Production ranges from 1,000 to 1,800 lbs/acre.



VEGETATION TYPES – WRC LEASES

MAP 3-4

3.6.3 Low-Elevation Big Sagebrush Type

The low-elevation big sagebrush type is characterized by sagebrush that averages less than 18 inches in height. More than 40 percent of the area is bare ground. Elevation ranges from 6,000 to 7,000 feet, with slopes ranging from 0-15 percent with variable aspects. Associated understory vegetation includes Douglas rabbitbrush, shadscale, winterfat, Indian ricegrass, western wheatgrass, and scarlet globemallow. Production ranges from 600 to 1,800 lbs/acre.

3.6.4 Hillside Bunchgrass Type

The hillside bunchgrass type is characterized by steep shale slopes and rock outcrops with no significant vegetation. Elevation ranges from 6,000 to 6,500 feet, with slopes greater than 50 percent and aspects south or southeast. This combination of aspect, slope, and soil conditions produces a xeric site. Predominate species include slender wheatgrass, Indian ricegrass, and shadscale. Production on this site would be less than 400 lbs/acre.

3.6.5 Threatened, Endangered, Candidate, and Sensitive Plants and Remnant Vegetation Associations

Eleven sensitive plant species are known to occur within the Piceance Basin. To date, no federally listed threatened or endangered species have been recorded. (A listing of the "Status of Rare and Sensitive Plant Species that occur in the Piceance Basin" is located in the Draft Piceance Basin RMP/EIS, Volume 1.)

Astragalus lutosis, a federally listed Category 2 plant and a sensitive status plant by the Bureau of Land Management in Colorado, is located to the north and east of the proposed project area on steep slopes of Green River Formation shale and Uinta Formation sandstone. Although no populations are known to exist on the project site, approximately 1 acre of potential habitat exists within the well field in the 500,000 TPY Alternative.

The proposed project site is almost entirely encompassed within an area nominated by The Nature Conservancy for designation as an area of critical environmental concern (ACEC). BLM determined that the nominated site was not eligible for further consideration as an ACEC, as it did not meet the relevant planning criteria; however, this decision is currently under protest and has not yet been resolved.

The Nature Conservancy's 1982 inventory of the Piceance Basin identified a Remnant Vegetation Association (RVA) within the project area. This 45-acre RVA is a big sagebrush (*Artemisia tridentata wyomingensis*) — western wheatgrass (*Agropyron smithii*) vegetative type that The Nature Conservancy considers to be in good condition. This plant association is common in the project area and the region; however, this association is of special concern in Colorado and has been ranked by the Colorado Natural Heritage Inventory. The Colorado Natural Heritage Inventory ranks vegetative associations based on occurrences, range, and kinds and significances of current threats to the occurrences. Plant communities are placed on the list because they are threatened by either extirpation or by wide scale alteration from a variety of forces. "Some associations on this list are still extant and widespread in a degraded condition, but are on the list because relatively unaltered or pristine examples are exceedingly rare or unknown, or are not adequately protected from the current threats" (Colorado Natural Heritage Inventory 1983).

3.7 Livestock Grazing

The proposed project is located on the Square S Allotment (No. 6027). This allotment contains 64,050 acres of public land, which provides forage for approximately 1,000 cattle during the period from May 1 to December 15. The cattle are on base property when not licensed for the public lands. The proposed project and alternatives are located within Pasture B, which has alternating yearly use between May 23 to June 7 and November 1 to December 5.

Within the project area there are two range improvement projects that could be affected by the proposal. A water pipeline (No. 4420) traverses the well field and plant site. A pasture fence (No. 4419) crosses the corner of the 500,000 TPY Alternative well field. Access, transmission, and natural gas lines cross pasture fences and water pipelines.

3.7.1 Wild Horses

Approximately seven to nine wild horses use the project area on an intermittent basis. The project area is not within the White River Resource Area Herd Management Area and these horses will not be retained.

3.8 Wildlife

Wildlife resources in the project vicinity have received extensive coverage in past documents (e.g., USDI, BLM 1982, 1983a). In addition, VTN Consolidated, Inc., conducted additional field surveys for WRC on the proposed project area in 1984 (WRC 1984). Approximately 28 mammal, 66 bird, 5 reptile, and 1 amphibian species are known or thought to inhabit WRC's lease tracts on a year-round or seasonal basis. Only those animals and habitats that may be significantly affected by proposed developments or are of major state/federal concern will be discussed in detail.

3.8.1 Big Game

Four big game species occur in Piceance Basin—mule deer, elk, mountain lion, and black bear. Mule deer predominate in terms of total numbers and recreational value.

Mule Deer: Historically, Piceance Basin has supported one of the largest migratory mule deer herds in North America. Deer populations have fluctuated dramatically in the basin since the 1950s, primarily because of weather conditions that influence winter severity and seasonal range conditions. The current posthunt population estimate (January 1985) of deer wintering in Piceance Basin is approximately 22,000 (Ellenberger 1985), which is considerably lower than the Colorado Division of Wildlife (CDOW) population goal of approximately 40,000 animals.

Deer in Piceance Basin use a variety of habitats on a seasonal basis. They occupy higher elevation ranges that are made up of mountain shrubs, aspen, and Douglas fir in the summer. During the winter, deer concentrate in pinyon-juniper and sagebrush ranges below 7,400 feet, where snow depth and temperatures are more moderate.

The project area is used by deer exclusively during the winter, appearing first in September with the onset of fall migration. Densities increase steadily through January and remain fairly constant through February. At this time, deer begin to follow the receding snowpack and are essentially absent from the sodium lease area by late May. Fall and spring migration (September-October, April-May) may involve concentrated deer movement across the project area.

On the sodium lease tracts, deer use in the winter is associated with pinyon-juniper woodlands where cover and preferred forage are most readily available. Browse species preference tests conducted on the sodium lease tracts by LGL Ecological Research Associates in 1981 (WRC 1984) indicated that deer select antelope bitterbrush in fall and early winter. As snow depth increases and as bitterbrush becomes less available, they shift to diets comprised of sagebrush and pinyon-juniper herbage. Beginning in late February, deer seek emerging herbaceous growth and make increasing use of agricultural lands and sagebrush bottoms.

CDOW has categorized range values important to mule deer in Piceance Basin. Categories pertinent to the project area are: 1) winter range—that part of the home range where 90 percent of the individuals are located during a site-specific period of winter during the average five winters out of ten; 2) severe winter range—that part of the range where 90 percent of the individuals are located when the annual snowpack is at its maximum in the two worst winters out of ten; 3) critical habitat—a designation that may be applied to any biological feature mapped for a species thus indicating that, within a given area, loss of that biological feature could adversely affect that species.

Depending on the alternative, from 70 to 100 percent of the winter range involved with the projects are considered critical habitat in the form of severe winter range (Map 3-5). These specifically defined winter ranges are essential to herd sustenance during winters of unusually severe and prolonged inclemencies, when adjacent winter range resources are unavailable or inaccessible.

Based on pellet group counts and aerial surveys, LGL (WRC 1984) estimated that deer densities on the sodium lease tracts during the winter of 1981 were 67 deer per square mile in chained pinyon-juniper, 26 per square mile in pinyon-juniper woodland, and 13 per square mile in sagebrush. The Piceance deer herd was at one of its lowest recorded population levels in 1980-1981, and winter conditions were unusually mild. Higher animal densities would be expected here during more severe winters and with deer populations at higher levels. CDOW estimated overall population densities at 54 per square mile on local winter ranges and 80 per square mile on severe winter ranges (1978-1979 figures).

Elk: Winter elk use has become increasingly evident in lower elevation pinyon-juniper ranges of Piceance Basin, including the sodium lease tracts. However, the area is not one that is frequented regularly by elk and is not considered important elk habitat.

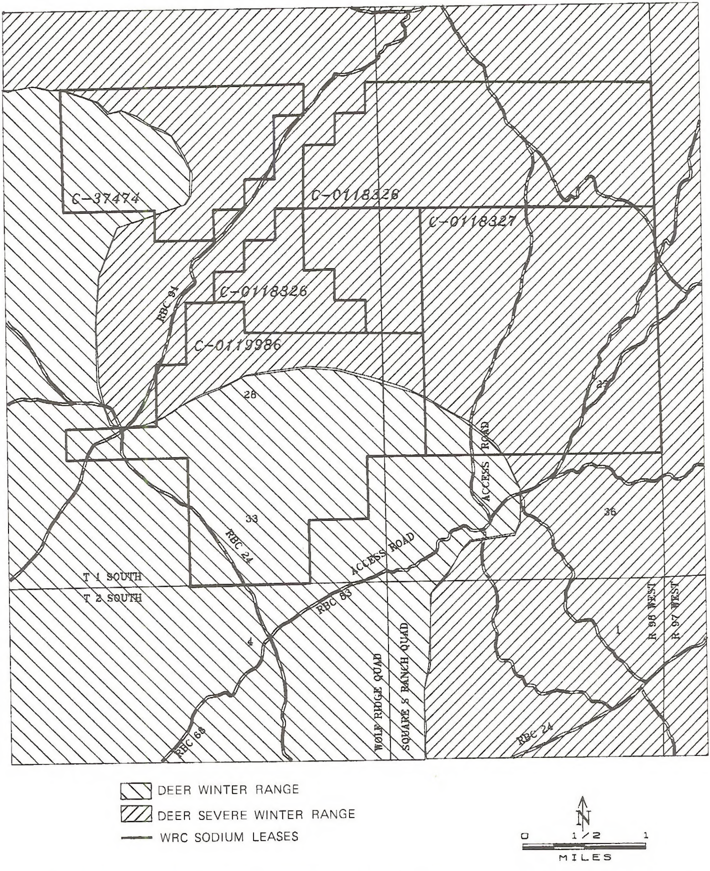
Mountain Lion: Seasonal use areas for lion coincide with those for mule deer, their primary prey. Average lion density in Piceance Basin is calculated by CDOW to be about four lions per 100 square miles.

Black Bear: A stable population of 10 to 20 bear inhabit Piceance Basin's higher elevational ranges, although individual bear appear infrequently on low elevation pinyon-juniper ranges.

3.8.2 Raptors

The Piceance Basin is inhabited throughout the year by a variety of raptors. Common breeders include American kestrel, long-eared owl, great horned owl, golden eagle, red-tailed hawk, and Cooper's hawk. The sharp-shinned hawk and northern goshawk are relatively rare breeding residents. Rough-legged hawk, northern harrier, and bald eagle forage in open vegetative types throughout the basin during the winter months. An influx of sharp-shinned hawk and goshawk also occurs in the forested areas during the winter.

Generally, local breeding raptors construct nests or return to traditional nest sites in mid-February to late April to lay eggs sometime in March or April. Nest occupation



MULE DEER WINTER RANGE – WRC LEASES

MAP 3-5

continues until chicks are fledged, which, depending on when nesting activities began, occurs from early June to mid-August.

WRC conducted a raptor survey during June and July 1984. Over the course of the survey, one great-horned owl was observed along the western boundary of section 27; no evidence of nesting was found. The only nest located was an inactive stick nest (i.e., Cooper's or red-tailed hawk) situated in a pinyon pine along the northern boundary of section 27.

LGL (WRC 1984) reported 20 cliff nests within 1 mile of the sodium lease tracts. Only two nests (one red-tailed hawk, one golden eagle) were active then. None of these nests is located within 1 mile of the project area.

The proposed project area does not appear to contain habitat supporting a large variety or population of breeding raptors. Raptor use may increase during the winter months with the influx of winter residents, but no data exists to substantiate this.

3.8.3 Upland Game Birds and Waterfowl

Sage Grouse: Primary sage grouse populations in Piceance Basin are distributed south and west of the sodium lease tracts. Sage grouse are not regular or common inhabitants of the immediate project area. Neither birds nor sign were observed on the facility or well field sites during June 1984 surveys (WRC 1984). 84 Mesa (3 miles east) and Bar D Mesa (immediately southeast of the project area) seem to support regular, low-density winter and spring use (WRC 1984). As many as 35 birds were seen for a week in February in the vicinity of the proposed Bar D Mesa access road (Clark 1985).

The closest historical strutting ground is located on 84 Mesa. No strutting activity has occurred on this site since 1981.

Mourning Dove: Dove are ubiquitous summer residents in Piceance Basin, nesting in all available habitat types. Nesting densities in the project area are probably similar to or less than that recorded for Tract C-b, approximately 52 birds per square mile.

Waterfowl: Waterfowl seasonal use areas are associated with seasonal or perennial aquatic habitats along Piceance Creek, Yellow Creek, and their major tributaries. Yellow and Piceance creeks sustain a very limited number of nesting mallard and cinnamon/green-winged teal, but often support high migration-related use during September to November and April to May. Aquatic habitat suitable for waterfowl use does not exist in the project area itself.

3.8.4 Furbearers and Nongame Animals

Populations of furbearers, small mammals, nongame birds, reptiles, and amphibians in the project area are characteristic of and common to mid and low elevation pinyon-juniper and sagebrush ranges throughout Piceance Basin. Values derived from LGL inventories (WRC 1984) for species composition were similar, and relative abundance, density and diversity were similar to or slightly lower than figures reported by Cathedral Bluffs Shale Oil Company (1981).

3.8.5 Threatened and Endangered Species

There are four federally listed species that may be present in the project area, or which could be influenced by project implementation: the Colorado squawfish, humpback chub, bonytail chub, and bald eagle. The razorback sucker, a state-listed endangered species and a federal candidate species, will also be addressed.

Of the listed and candidate fishes, only the squawfish occupies the White River in Colorado. Squawfish distribution extended as far upstream as Piceance Creek until the construction of the Taylor Draw Dam blocked access in November 1984. Although adult and juvenile squawfish have been regularly collected from the White River, no young-of-the-year or larval forms have appeared to date, indicating that spawning or nursery areas do not exist in Colorado's portion of the White River.

All the fishes identified above including the razorback sucker have known downstream populations in the Green River and Colorado River above Lake Powell. A common denominator among all these fish is the apparent value of quiet backwater areas, particularly with respect to their reproductive biology. Each of the species seems to require riverine backwater areas for larval development (nursery areas) and respite from periods of high flow.

The apparent importance of the White River to endemic fish in the Upper Colorado River Basin is its flow contribution to the Green River. Major Green River tributaries, such as the White River, are thought to exert a strong influence on the reproductive success of endemic fishes known to spawn in the Green River.

Bald eagles reside in the White River valley from October though March as winter residents and migrants. Core populations in winter vary from 50 to 70 birds, with migratory peaks of up to 160 birds in March. Bald eagles roost in cottonwood stands and Douglas fir stands along the White River and forage upland, usually in nonforested vegetative types. Foraging eagles are regularly encountered in Piceance Basin during the winter months, but their foraging activities appear to be widely dispersed and wholly opportunistic; there is no documentation of preferred or concentrated use areas.

See BLM's Biological Assessment to the USFWS (Appendix D) for additional information on listed and candidate threatened and endangered animals and plants.

3.8.6 Aquatic, Wetland, and Riparian Habitats

The USFWS and CDOW have classified all streams in the vicinity of the sodium lease tracts as having limited game fisheries potential and low resource value. The White River downstream from Rio Blanco Lake, which includes the confluence with the Yellow Creek drainage system, is classified both as an endangered species fishery and a limited game fishery.

The Colorado Department of Health has determined that the mainstem of Yellow Creek and its tributaries do not qualify for recreational or aquatic life classifications, and no numeric standards are applicable.

No riparian, wetland, or aquatic habitats exist on the project site itself. Yellow Creek (west of the sodium lease tracts) and Piceance Creek (east of the tracts) support localized areas of riparian and wetland habitats where seasonal and perennial surface water sources are available. Potentially affected wetland zones are primarily confined to unused channels and are characteristically a simple, poorly developed herbaceous type. Perennial reaches of lower Yellow Creek in particular are subject to regular occurrences of flash flooding. Attendant channel scouring and silt deposition virtually eliminated opportunities for development of a well established wetland/riparian community.

3.9 Cultural Resources

Cultural resources known to exist within the area that would be affected by the Proposed Action and alternatives include 16 sites and 11 isolated finds (IFs) (Table 3-5). Fifteen of the sites are prehistoric and one is a historical site. Of the 15 prehistoric sites, five have been classified as open lithic sites, seven are open campsites, and two are rock shelters. The one recorded historical site is a homestead.

The site density on the project study area is 27 cultural resources per section. This is high compared to the site density on sodium lease C-0118329, 9.3 sites per section (Conners et al. 1980), and the 16.6 sites per section on Oil Shale Tract C-a lease (McPherson 1983).

It appears, with the exception of the 138 kV powerline associated with the 500,000 TPY Alternative (powerline route not currently known), that all locatable cultural resources on the surface in the project area have been identified by previous inventories.

3.10 Paleontological Resources

According to Colorado BLM policy (Colorado State Office Instruction Memorandum 85-189), all geologic formations must be classified according to their scientific significance regarding paleontological resources. The Uinta and Green River formations, the two formations that crop out on the sodium lease tracts, have been classified as Class Ib (Lucas and Kihm 1982). Class Ib formations are those "with a high potential for producing scientifically significant fossils" (Lucas and Kihm 1982).

The surface formation exposed in the area of the Proposed Action and alternatives is the Uinta Formation (Cashion 1973, Duncan 1976). The Uinta Formation in the Piceance Basin has yielded a variety of plant and animal fossils such as Crocodilia bones, vertebrate bones, turtle shell fragments, and petrified wood specimens. One fossil locality north of the lease area has yielded a *Uintatherium* skull (Lucas and Kihm 1982). An inventory of Sodium Lease C-0118326, which includes the proposed mining area, revealed a fossil locality (5RB1923) that yielded eight pieces of a skull tentatively identified as a *Titanothere* (Conners et al. 1980). The area around 5RB1923 also contains three additional fossil localities. Two additional fossil localities are known to occur on the northwest end of the 500,000 TPY well field.

3.11 Lands and Realty

WRC holds four sodium leases totalling 8,222 acres. The Proposed Action would involve development within two contiguous sodium leases, C-0118327 and C-0119986. Under the 50,000 TPY Alternative, only part of sodium lease C-0118327 would be developed. Under the 500,000 TPY Alternative, portions of three adjacent sodium leases, C-0118327, C-0119986, and C-0118326, would be developed. WRC's fourth lease, C-37474, is not under development consideration at this time.

All four of WRC's sodium leases are withdrawn for oil shale under Public Land Order 4522. Six oil and gas leases overlap the four sodium leases. The sodium leases have prior valid existing rights to the overlapping oil and gas leases.

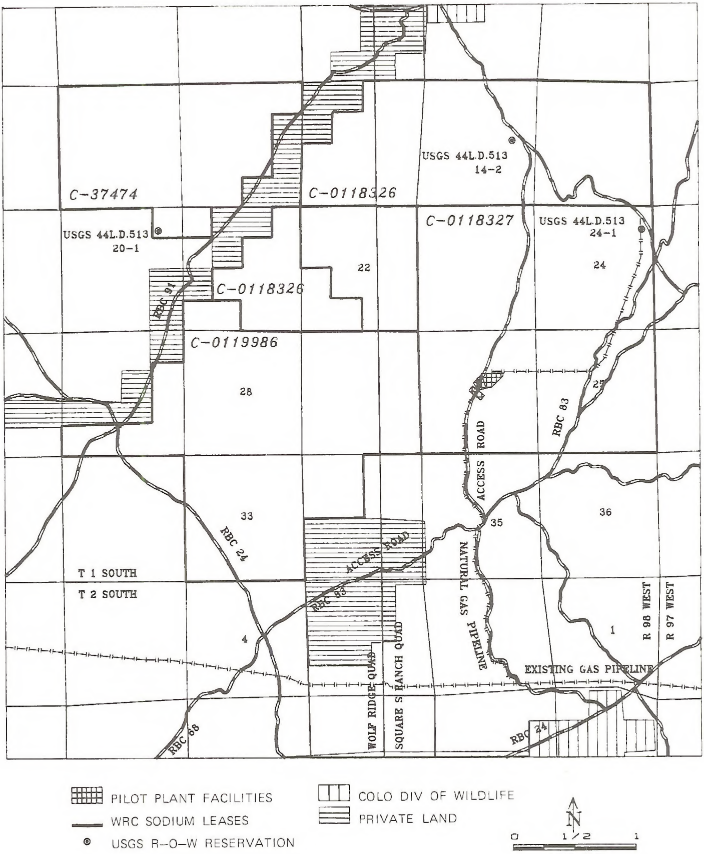
Colorado state lands administered by the Colorado Division of Wildlife adjoin the sodium leases to the northwest along Yellow Creek, Rio Blanco County (RBC) Road 91, and 3 miles to the south in Ryan Gulch, RBC Road 24 (Map 3-6). One mile of RBC Road 83 proposed as mine access crosses private land owned by Shell Oil Corporation. Oil Shale Tract C-a lies approximately 6 miles to the west of the sodium leases.

TABLE 3-5

KNOWN CULTURAL RESOURCES WITHIN THE PROPOSED ACTION AND ALTERNATIVES PROJECT AREA

Site/ Isolated Find No.	Type	Cultural Period	NRHP Eligible	Management Records	Recording Institution	Date Recorded
5RB319	Open campsite	?	Potential	None provided [1]	CSU-LOPA	1976
5RB392	Open lithic	?	No	No further work	CSU-LOPA	1976
5RB394	Open campsite	?	No	No further work	CSU-LOPA	1976
5RB396	Open lithic	?	No	Test if threatened	CSU-LOPA	1976
5RB398	Open campsite	Late Prehistoric	Eligible	None provided [1]	CSU-LOPA	1976
5RB408	Open lithic	?	No	Test if threatened	CSU-LOPA	1976
5RB410	Open campsite	?	Yes	None provided [1]	CSU-LOPA	1976
5RB558	Open lithic	Archaic	Not given [2]	None provided [1]	DU	1975
5RB596	Open lithic	?	Not given [2]	Mitigate if threatened	DU	1975
5RB646	Historic Homestead	Historic	Not given [2]	Test if threatened	Centuries	1976
5RB1877	Open campsite	Archaic	Potential	Avoid or plane table map-surface collect, test prior to disturbance	GRI	1980
5RB1880	Open campsite	Archaic?	No	Avoid or plane table map, surface collect, test prior to disturbance	GRI	1980
5RB1886	Rock Shelter	?	Potential	Avoid	GRI	1980
5RB1887	Rock Shelter	?	Potential	Avoid	GRI	1980
5RB1895	Hearth	?	Potential	Avoid	GRI	1980
5RB1900	IF-1 flake	?	N/A	None provided	GRI	1980
5RB1901	IF-Biface fragment	?	N/A	None provided	GRI	1980
5RB1903	IF-Uniface flake	?	N/A	None provided	GRI	1980
5RB1906	IF-Interior flake	?	N/A	None provided	GRI	1980
5RB1907	IF-Mano	?	N/A	None provided	GRI	1980
5RB1910	IF-4 flakes	?	No	None provided	GRI	1980
5RB1912	IF-Core	?	N/A	None provided	GRI	1980
5RB1913	IF-1 flake	?	No	None provided	GRI	1980
5RB1917	IF-Mano 2 flakes	?	N/A	None provided	GRI	1980
5RB1923	Paleontological	N/A	Potential	Test prior to disturbance	GRI	1980
5RB2500	Open campsite	?	Not given [2]	Avoid	GRI	1983
5RB2502	IF-1 flake	Fremont?	N/A	None provided	GRI	1983
5RB2734	IF-5 flakes	?	N/A	None provided	GRI	1985

[1] These sites will have to be relocated and recommendations made for management.
[2] These sites will have to be relocated and reevaluated for Register eligibility.



LAND USE MAP

MAP 3-6

Three of WRC's sodium leases surround a 503.94-acre parcel of federal land in section 22 adjacent to the proposed well fields (Map 3-6). The federal government has leased this parcel for oil and gas, but not for sodium.

The United States Geological Survey (USGS) holds an implied reservation dating from April 8, 1975, on the Wolf Ridge 24-1, 14-2, and 20-1 water wells under the auspices of 44 L.D. 513 (1916). USGS has a recognized right-of-access to monitor these wells and holds the responsibility for final plugging and abandonment (Map 3-6).

There are two rights-of-way in the sodium lease vicinity. Industrial Resources, Inc. (IRI), obtained these grants for a 2-year period in connection with the initial pilot facility; their expiration date is July 11, 1986. IRI has assigned the access road authorization C-37773 to Wolf Ridge Corporation. The other right-of-way, a temporary surface pipeline C-37772, has not been built; because of changes in the pilot plant mine plan, these rights will not be exercised. WRC is seeking new authorization for a buried natural gas pipeline in association with their proposed commercial-scale sodium mine (Map 3-6).

Wildlife use and livestock management are the predominant existing land uses in the sodium lease vicinity.

3.12 Recreation/Visual Resources

3.12.1 Recreation

The proposed mining area is located entirely within a semiprimitive-motorized recreation opportunity area. This area is managed as part of the White River Extensive Recreation Management Area. Hunting of big game is the dominant recreational activity occurring on the public lands in the vicinity of the proposed mining area. Secondary recreational activities include camping, off-road vehicle use, picnicking, wood gathering, and nature study. No developed facilities are available for these activities, and the area is currently managed at a low level for recreation.

A more in depth discussion on recreational activities and opportunities in the Piceance Basin area is available in the Draft EIS for Federal Prototype Oil Shale Tract C-a Offtract Lease (USDI, BLM 1985b).

3.12.2 Visual Resources

The area encompassed by the Proposed Action and project alternatives is entirely within a Class IV Visual Resource Management (VRM) area. Changes to the environment in this area can result in contrasts that may attract attention and be a dominant feature of the landscape in terms of scale; however, the change should repeat the basic elements inherent in the characteristic landscape. The project area is a mixture of pinyon-juniper woodland and sagebrush/grassland. The scenic quality rating applied to the area is Class C—an area in which the features are fairly common to the physiographic region.

3.13 Transportation

Major highways and county roads that serve the proposed project area are State Highway 13 from Rifle to the junction with Rio Blanco County (RBC) Road 5, State Highway 64 from Meeker to the junction with RBC Road 5, RBC Road 5 from State Highway 13 and State Highway 64 to RBC Road 24, RBC Road 24 to the intersection with RBC Road 83; and RBC Road 83 from RBC Road 24 to the center of section 35. Access then continues along existing BLM dirt roads to the center of section 26, Township 1 South, Range 98 West. Please see Map 1-1 in Chapter 1 for a general road description. Map 3-6 in Chapter 3 shows the detailed site-specific access route.

All road segments have a designed capacity of 450 vehicles per hour, Peak Hour Traffic (Colorado Department of Highways 1982 and 1983).

3.14 Noise

The proposed mine site is located in open, broken country primarily used by livestock and wildlife. Ambient sound levels range from 25-35 decibels (dB) in the absence of major human activity (Rio Blanco Oil Shale Company, Tract C-a 1977). Noise levels on the county roads are 35-40 dB because of the traffic to and from Oil Shale Tract C-a, located approximately 6 miles west of the proposed sodium mine. There are no permanent dwellings within a mile of the mine site.

3.15 Socioeconomics

3.15.1 Social

The Draft Piceance Basin RMP/EIS (USDI, BLM 1984) is the best reference for social descriptions of Meeker and Rifle, the two communities that would be affected by the WRC proposal or project alternatives. The following updates that document.

As a result of the declining interest in oil shale development, some social and other services have suffered in Meeker, but only a few businesses have failed. This conservative town has reacted more slowly than others in the region to the expected boom. Although over 162 houses are currently vacant, the tendency has been to hold off selling because of the hope that the oil shale industry will "go" again; thus, both rent and sale prices have remained high.

The temporary boom from Western Fuels mine construction east of Rangely has ended. A small work force exists until the Bonanza Power Plant is completed and operational, at which time the coal mine will go into full production. Both Meeker and Rangely will benefit from the project. The completion of the Taylor Draw Dam has had negligible social effects.

When federal prototype oil shale lease tracts C-a and C-b were originally under construction, about 70 percent of their work force commuted from the Rifle area. The town expanded its facilities rapidly to keep up with the growth from these projects and the Parachute Creek oil shale operations. Unfortunately, shutdowns have left Rifle overbuilt and financially troubled.

Rifle and Rangely, more than Meeker, have moved away from their traditional conservatism and now actively seek growth.

3.15.2 Economics

The Draft EIS for the C-a Offtract Lease proposal is the best reference for economic conditions of Meeker and Rifle, Colorado, the two communities that would be affected by WRC's Proposed Action or project alternatives. The following summarizes and updates that document.

3.15.2.1 Employment and Income

Employment and income figures for 1982 (Table 3-6) reflect the oil shale projects before their suspension. Present employment (1985) levels are lower, especially in Rio Blanco County. Garfield County construction levels continue to grow.

3.15.2.2 Population

An uneven population distribution continues to characterize the study area. Garfield County's population is heavily concentrated in the central and eastern parts of the county. Settlement in Rio Blanco County is clustered around the two communities of Meeker and Rangely. Areas between these population islands consist of sparsely settled ranching country and unpopulated state or federal land. The population figures shown in Table 3-7 are by the Census Bureau's Census County Divisions.

TABLE 3-7

1985 POPULATION

	County	County Division	Community
GARFIELD COUNTY	29,095		
Glenwood Springs Division		15,711	
Carbondale			3,192
Glenwood Springs Area			9,179
Grand Valley Division		1,728	
Parachute			868
Battlement Mesa			458
New Castle Division		4,564	
New Castle			1,174
Silt			1,095
Rifle Division		7,092	
Rifle Area			4,565
RIO BLANCO COUNTY	6,737		
Meeker Division		3,719	
Meeker			2,611
Rangely Division		3,018	
Rangely			2,466

Source: Colorado Division of Local Government; Planning and Assessment System and BLM estimates.

3.15.2.3 Housing

Vacancy rates were less than 10 percent in 1984 (indicative of a housing shortage) in only one community, Rangely. All other communities show less stringent conditions since the "energy boom of the late 1970s." Most communities could absorb light to moderate growth with existing housing stock. Vacancy levels in Table 3-8 should be read with caution because the housing stock does not indicate either physical condition or whether they are year-round or seasonal units.

TABLE 3-6

CURRENT EMPLOYMENT BY PLACE OF RESIDENCE

	Employment			Percent of Total		
	1980[a]	1982[a]	1985[b]	1980	1982	1985
Garfield County						
Agriculture	596	572	550	5.3	4.2	3.2
Mining	608	817	730	5.4	6.0	4.1
Construction	1,241	2,087	3,226	11.0	15.4	18.6
Manufacturing	213	291	319	1.9	2.2	1.8
Trans., Comm., Utilities	772	862	1,012	6.9	6.4	5.8
Trade	2,256	2,604	3,334	20.0	19.2	19.5
Finance, Ins., Real Estate	358	403	634	3.2	3.0	3.6
Services	1,780	2,006	2,725	15.8	14.8	15.7
Government	1,977	2,372	2,910	17.6	17.6	16.6
Unclassified	1,450	1,528	1,986	12.9	11.3	11.3
Total	11,253	13,547	17,426	100.0	100.0	100.0
Total Labor Income $(000)	146,847	200,570	312,227			
Percentage Unemployment	4.1	8.2	9.0			
Rio Blanco County						
Agriculture	290	277	263	6.1	5.0	7.3
Mining	1,563	1,624	757	32.7	29.2	21.1
Construction	1,097	1,445	189	22.9	26.0	5.2
Manufacturing	30	60	40	.6	1.1	1.1
Trans., Comm., Utilities	180	203	306	3.8	3.6	8.6
Trade	375	475	421	7.8	8.6	11.8
Finance, Ins., Real Estate	24	39	82	.5	1.7	2.2
Services	160	237	250	3.3	4.3	7.0
Government	724	828	861	15.1	14.9	24.1
Unclassified	345	367	414	7.2	6.6	11.6
Total	4,788	5,558	3,583	100.0	100.0	100.0
Total Labor Income $(000)	92,557	109,119	73,363			
Percentage Unemployment	1.9	5.1	6.3			

[a] From the Draft EIS for the Federal Prototype Oil Shale Tract C-a Offtract Lease (USDI, BLM 1985).

[b] BLM estimate.

3.15.2.4 Agriculture

Livestock production remains the principal agricultural activity in Garfield and Rio Blanco counties. Crop production is dominated by hay for livestock use. See the Draft C-a Offtract Lease EIS for livestock and crop production values.

3.15.2.5 Recreation

Hunting is the only significant economic recreational activity on the proposed site. In 1981, an estimated total of 87,000 days were spent by all hunters in Rio Blanco County. The average value per day in 1980 dollars (McKean and Weber 1978) for nonresident hunters is $56.00. The economic value to the county from these hunters was about $4,872,000.

TABLE 3-8

1984 HOUSING UNITS [a]

	Single Family	Multi-Family	Mobil Home	Total	Percent Vacant	Vacant [b]
Garfield County						
Carbondale	935	310	241	1,486	.10	148
Glenwood Springs	1,798	1,247	421	3,466	.10	346
New Castle	196	20	68	284	.15	43
Parachute [c]						
Rifle	1,154	379	209	1,742	.17	321
Silt	229	40	139	408	.16	61
Rio Blanco County						
Meeker	727	200	112	1,039	.15	162
Rangely	500	116	191	807	.09	72

[a] Colorado Division of Local Government; Planning and Assessment System.

[b] BLM estimate based upon survey of each city's planning department 12/7/84.

[c] Data not available for 1984.

3.15.2.6 Mining

Mining is the most important industry in Rio Blanco County. In 1984, it provided 34 percent of total employment and 89 percent of basic industry sales. Oil and gas are the dominant products, accounting for 98 percent of the $417 million value of mineral production in 1982. Coal and oil shale provided most of the remaining mineral production (Colorado Department of Natural Resources 1983).

3.15.2.7 Local Government Finances

A description of the local government finance structure and how revenue is obtained is given in the Draft C-a Offtract Lease EIS (USDI, BLM 1985b). Table 3-9 lists the 1984 local government financial data by community.

School district financial data remains the same as that presented in the Draft C-a Offtract Lease EIS. All school districts have sufficient bonding capacity to meet low to moderate growth levels.

TABLE 3-9

1984 LOCAL GOVERNMENT FINANCIAL DATA

	Carbondale	Glenwood Springs	Silt	Rifle	New Castle	Parachute	Meeker	Rangely
Source of Revenue (1984)								
% Local [a]	87	94	25.4	56.9	93	94	71	77.5
% State [a]	9	4	65.7	4.6	5	3	23	21
% Federal [a]	3	1	7.9	1.6	1	2	3	5
% Other Units [a]	1	1	1	36.9	1	1	3	1
Assessed Valuation (1/1/84)	11,570,470	36,802,880	3,113,770	23,229,300	1,722,600	3,710,250	9,808,690	10,640,070
Total (000) Estimated per Capita	4,078	4,688	3,307	5,088	2,713	4,844	4,078	4,935
Mill Levy (1/1/84)	6,678	575	1,344	8,221	8,461	22,224	6,662	14,344
Retail Sales (FY 82)	21,146,987	192,786,399	3,273,428	76,675,811	N/A	N/A	21,001,887	56,411,440
Bonded Debt (1/1/83)							0	199,000
General Obligation (000)	50,000	3,315,000	2,000	369,000	145,000	0	1,294,700	640,000
Revenue (000)	3,060,700	2,040,000	292,500	646,700		0		
Remaining Bonding Capacity [b]	1,107,047	[b]	309,377	[b]	27,260	372,000	980,869	865,007

[a] Division of Local Government, Local Government Financial Compendium for 1984, and BLM estimate.

[b] BLM estimate.

4. ENVIRONMENTAL CONSEQUENCES

4. ENVIRONMENTAL CONSEQUENCES

This chapter discusses the environmental impacts that would be expected from each of the alternatives described in Chapter 2. Climate, locatable and salable minerals, floodplains and wetlands, wilderness, wild and scenic rivers, and areas of critical environmental concern will not be impacted; therefore, they are not discussed further in this document. All other resources are presented in the order that they appear in Chapter 3. Impacts are summarized at the end of this chapter to illustrate differences between alternatives.

This analysis assumes that all terms and conditions of the sodium leases will be adhered to (Appendix E).

4.1 Air Quality

The study area, or area which may be affected by these activities, includes the immediate vicinity of the sodium lease tracts in the Piceance Basin (within 30 kilometers of the tract boundaries), as well as more distant areas which are especially sensitive or subject to special protection under state and federal laws. The distant areas of concern are: the Flat Tops Wilderness Area, Mount Zirkel Wilderness Area, Dinosaur National Monument, and Colorado National Monument (see Map 3-1 in Chapter 3). The national monuments are categorized by the State of Colorado as Category I, which applies the same standards as federal Class I (wilderness areas and national parks). These categories and standards are described in detail in Appendix B "Air Quality Significance Criteria."

Impacts to air quality would occur from all alternatives considered in this environmental impact statement (EIS). These impacts would result from emission of air pollutants as a result of mining, product upgrading, and product handling. The pollutants that may be emitted are: particulate matter from product handling, fuel combustion, and vehicular traffic; sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and hydrocarbons (HC) from fuel combustion. State and federal regulations limit the amounts of these pollutants that may be emitted. Control equipment would be applied to the project where required, which will be discussed in more detail under each alternative analysis.

Potential impacts to air quality related values (AQRVs) were also analyzed, pursuant to Prevention of Significant Deterioration (PSD) regulations for Class I areas (see Appendix B for a description of these classes). Such impacts to AQRVs for the Class I areas within the study area would involve visibility degradation to scenic qualities and acid deposition impacts to high country lakes and watersheds.

Visibility impacts could result from increased concentration in the atmosphere of small, light scattering particles (such as sulfates and nitrates), or increases in light-absorbing gases (usually NO_2). Results of visibility monitoring over several years in the Piceance Basin indicate very high visibility ranges.

Acid deposition occurs as a result of chemical transformation in the atmosphere of certain pollutants (primarily SO_2 and NO_2) into acidic compounds. These acidic compounds may then be deposited in the form of highly acidic rain, snow, or as dry particles. Acid deposition is harmful only when it falls on areas that are sensitive to the acidity/alkalinity of precipitation.

The computer model used to predict ambient impacts was the Environmental Protection Agency (EPA) Complex I model. It was applied in a conservative manner; therefore, the values shown for ambient impacts should be taken as the upper limit of possible values, rather than the absolute value of each predicted concentration.

4.1.1 No Action Alternative

As Table 4-1 shows, all predicted pollutant concentrations from the pilot plant are well within the applicable standards, as defined by the significance criteria contained within Appendix B.

Under this alternative, particulate emissions will be controlled through the use of fabric filters and a cyclone separator on the product handling equipment and through periodic watering of the graveled access road to control dust. Nitrogen oxides (NO_x) will be controlled through the use of catalytic convertors on the generators. Based on emission rates of hydrocarbons and NO_x, there will be no significant formation of ozone from the pilot plant.

The EPA model predicted no impacts to any Class I/ Category I areas from the pilot plant operation. Concerning air quality related values, there will be no significant adverse impacts to visibility or acid deposition in any Class I/ Category I area.

Although not significant, there will be a small degradation of local air quality for the 2-year maximum project life.

Impacts from the pilot-scale project will not add significantly to any regional degradation of air quality that can be expected from the development of oil shale or other projects that have been planned for the area (i.e., baseline). Primarily because of the assumption put forth in this baseline that no commercial shale oil will be produced until the year 2000 (with the exception of Union), cumulative impacts will probably be significantly lower than those put forth

TABLE 4-1

MAXIMUM PREDICTED AMBIENT CONCENTRATIONS (MICROGRAMS PER CUBIC METER) RESULTING FROM WRC ALTERNATIVES

			No Action			50,000 TPY			Proposed Action/125,000 TPY			500,000 TPY		
Pollutant	Averaging Time	Background[a] Concentration	Predicted Concentration	Percent of Class II Increment	Percent NAAQS	Predicted Concentration	Percent of Class II Increment	Percent NAAQS	Predicted Concentration	Percent of Class II Increment	Percent NAAQS	Predicted Concentration	Percent of Class II Increment	Percent NAAQS
Particulates	Annual	11	7	36	24	7	36	24	1	5.3	16	4	21	20
	24-hour	55	23	62	30	24	62	30	14	38	27	48	130	40
SO_2	Annual	8	1	<1	10	0	0	0	0	0	0	1	5	11
	24-hour	30	1	<1	8	0	0	0	0	0	0	17	19	13
	3-hour	45	1	<1	—	0	0	0	0	0	0	42	8	—
CO	1-hour	575	2	—	1.4	2	—	1.4	18	—	1	7	—	1
	8-hour	387	1	—	3.9	1	—	3.9	15	—	4	18	—	1
NO_2[b]	Annual	9	1	—	10.5	2	—	11	3	—	12	5	—	14

[a] Draft C-a Offtract EIS, USDI, BLM 1985

[b] Predicted concentration modeled as NO_X.

in the C-a Offtract Draft EIS (USDI, BLM 1985b). These cumulative impacts are summarized as follows:

> For sulfur dioxide, the maximum 24-hour concentration will be 3.46 micrograms per cubic meter. This will be 69 percent of the allowable Class I increment, which will be within acceptable limits. The 3-hour and annual SO_2 concentrations were not calculated since studies in the past (Putnam, Hayes and Bartlett, Inc. 1982) have shown that the 24-hour increment would be the most restrictive.
>
> For particulates, the maximum 24-hour concentration will be 1.76 micrograms per cubic meter, which is 18 percent of the increment. This figure includes emissions only from the projects shown in Table IV-7 of the Draft C-a Offtract Lease EIS; no emissions from population and other secondary growth were analyzed. According to earlier studies, these secondary sources contribute over 80 percent of all particulate emissions (USDI, BLM 1982 and 1983a). These studies have indicated significant impact from secondary sources, including Class II PSD increments and National Ambient Air Quality Standards being exceeded in and near the major towns of the region.
>
> In the case of acid deposition, significant levels of total deposition were predicted for the Flat Tops Wilderness Area (3.55 Kg/ha-yr for sulfur and 6.65 Kg/ha-yr for nitrogen). Since no standards for nitrogen deposition or for total sulfur-nitrogen deposition currently exist, it is impossible to quantify the impact of this level of acidic deposition.
>
> For visibility, no method currently exists to assess the impact of cumulative emissions on region-wide visibility; however, there will a potential for degradation of region-wide visibility due to cumulative air emissions (US EPA 1979).

4.1.2 Proposed Action (125,000 TPY) Alternative

Table 4-2 shows a comparison of the total emission rates, in tons per year, for the 125,000 TPY Alternative with the No Action (Pilot Plant) Alternative and the EPA significant emission levels. Although production has increased by a factor of 2.5, the particulate emission rate is very close to that of the pilot plant. This is because the project proponent would pave the access/haul road under the Proposed Action. The other changes are a drop in SO_2 emissions and large increases in emission of NO_2 and hydrocarbons. These changes reflect both the increased production rate and the change in fuel for the boiler and generator from diesel fuel to natural gas.

TABLE 4-2

EMISSION RATES FOR ALTERNATIVES VS. NO ACTION (PILOT PLANT) AND EPA SIGNIFICANT EMISSIONS (Emissions Rate Tons Per Year)

Pollutant	EPA Significant Level [b]	No Action Pilot Plant	50,000 TPY	Proposed Action 125,000 TPY	500,000 TPY
Particulates	25	99 [a]	102 [a]	112	257
SO_2	40	13	0.2	0.4	105
CO	100	42	32	54	26
NO_2 [c]	40	75	110	186	420
HC	40	15	102	170	8

[a] Includes 86 tpy of fugitive particulates from gravel road.

[b] Level of emission above which new source review is required by EPA. (USEPA PSD Workshop Manual 1980)

[c] Predicted concentration modeled as NO_x.

Table 4-1 shows the maximum predicted ambient concentrations from the 125,000 TPY Alternative. As in the No Action Alternative, all would be within acceptable limits, as defined by the significance criteria selected for this EIS (Appendix B). No measurable impacts to Class I/Category I areas were predicted. Based on the ratio of nonmethane hydrocarbon emissions to nitrogen dioxide emissions, no significant production of ozone is predicted for this alternative.

There would not be any significant impacts to visibility or acid deposition.

Although not significant, there would be a small degradation of local air quality for the 30-year project life.

Cumulative impacts would be the same as those described in the No Action (Pilot Plant) Alternative.

4.1.3 50,000 TPY Alternative

Table 4-2 shows a comparison of the emission rates for the 50,000 TPY Alternative compared to the No Action (Pilot Plant) Alternative. The major differences are a large drop in SO_2 emissions and a large increase in hydrocarbon emissions caused by changing the boiler fuel from diesel to natural gas.

Table 4-1 shows the maximum predicted ambient impacts from the 50,000 TPY Alternative. Impacts would be similar to those described under the No Action Alternative, except there would be a small degradation of local air quality for 30 years, rather than for 2 years.

4.1.4 500,000 TPY Alternative

Table 4-2 shows the changes in emission rates from the No Action Alternative and other alternatives. The increase in particulate emissions is caused by four factors: the increased production rate (handling of additional dusty material), the addition of a bulk materials loading and handling step, additional facilities, and the switch from natural gas or diesel to coal for plant fuel. Extra particulate emissions would be controlled by the use of fabric filters for the bulk loading and truck loading operations, and the application of a baghouse or electrostatic precipitator to the coal-fired boiler.

Both sulfur dioxide and nitrogen dioxide concentrations would increase under this alternative. This would result from the use of coal for fuel instead of natural gas or diesel, as well as the increased demand for fuel. SO_2 would be controlled by flue gas desulfurization using nahcolite. NO_2 would be controlled by a catalytic conversion process.

There would be less carbon monoxide and hydrocarbon emissions than under the No Action Alternative because of the switch to coal as a fuel.

Table 4-1 shows the maximum ambient (pollutant) concentrations predicted for this alternative. The Class II PSD increment is predicted to be exceeded for particulate matter. There are several ways to address this. First, as previously stated, the model application used in this analysis is very conservative, tending to overestimate ambient impacts. If a more refined model were applied before approval by BLM of the 500,000 TPY Alternative, the lower estimate could possibly be within the acceptable limits. Second, the project proponent could submit more refined emission estimates, which could lower the predicted pollutant concentrations. Third, the proponent could provide for additional controls on particulate emissions, such as more extensive paving of the project areas or more stringent controls on the packaging and loading operations, which could lower total emissions.

Impacts from particulate matter and sulfur dioxide in Class I/Category I areas are predicted to be less than 1 microgram per cubic meter for all averaging times.

Based on the ratio of nonmethane hydrocarbon emissions to nitrogen dioxide emissions, no significant production of ozone is predicted under this alternative.

There would be no significant impairment of visibility within Class I/Category I areas attributable to this alternative. For acid deposition, a combined wet and dry rate of deposition of 3 kilograms per hectare-year for sulfates and 10 kilograms per hectare-year of nitrates are predicted. Studies in the past have used a threshold of 5 kilograms per hectare-year for sulfate deposition as the level below which no impacts to sensitive habitats are expected (USDI, BLM 1985a). No thresholds have yet been established for nitrate deposition; however, the combination of 3 kilograms sulfate and 10 kilograms nitrate per hectare-year should be considered as having a potential to cause adverse impacts to sensitive environments (USDA 1985).

Under this alternative, there could be a significant degradation of air quality due to particulate emissions for the 30-year project life. A small amount of degradation would occur from other pollutants for 30 years.

Cumulative impacts would be the same as those described in the No Action (Pilot Plant) Alternative.

4.2 Geology

4.2.1 Topography

The overall topography would not be significantly impacted by the Proposed Action or other alternatives. A short-term impact would occur on the immediate project area, as portions of the site were leveled and terraced to accommodate development. This would be restored when the areas were returned to approximate original contour during reclamation.

Under the Proposed Action, the 50,000 TPY, and the 500,000 TPY alternatives, subsidence could also potentially affect the topography. Subsurface subsidence, which would occur if the solution mined cavity roofs collapsed and/or pillars between cavities failed, would result in a downward surface expression of less than 1 foot. Although this would be an insignificant impact, subsidence monitoring (both surface and subsurface) as put forth under Section 2.4, Mitigation, would be required to confirm this. If actual impacts were determined to be greater than expected, the lessee would be required to mitigate such impacts.

4.2.2 Rock Quality

4.2.2.1 No Action Alternative

Rock quality of the strata immediately overlying the solution cavities could be affected if the cavities collapsed. However, analysis of information on rock mechanics provided by the applicant indicates that the small size of the cavities in the sodium, which will be developed by the pilot-scale project, should not affect the rock quality of the overlying oil shale (i.e., the Mahogany Zone). If the cavity roofs collapsed, the rubble in the leached zone would provide a bulking effect, which should minimize subsidence of overlying formations. Subsidence as a result of collapse of pillars between cavities should not be a problem for this small number of cavities (three maximum). The load directly above the pillars and cavities will be transferred through an arching effect to surrounding undisturbed ground. However, since the conditions estimated by the analysis of rock mechanics have never been measured under actual field conditions and because any damage to the overlying oil shale is of great concern to the Bureau of Land Management, the cavities shall be monitored to determine the effects, if any, of subsidence on the overlying oil shale. Such information is critical to providing information for future decisions on development.

The analysis indicated there would be no impact to rock quality of the strata beneath the Boies Bed.

4.2.2.2 Proposed Action

Rock quality of strata immediately overlying the proposed mining zone could be affected in two ways. First, collapse of the cavity roofs could result in caving of the overlying strata into the cavity. The effect of this caving would extend vertically until the cavity was bulked full. Water remaining in the cavities would provide some buoyant support to the cavity roofs. Secondly, subsidence of overlying strata could occur as a result of the pillars between cavities failing and crushing to a certain extent. The rock quality of the majority of the stratigraphic section above the dissolution surface to the Mahogany Zone is already very poor. Both caving because of collapse of cavity roofs and/or subsidence because of pillar failure would adversely affect rock quality of the overlying strata. The vertical extent of caving because of cavity roof collapse would be dependent on the height of the cavity and the bulking factor of the material overlying the cavities. The formula for predicting height of caving is:

$H = m \div (K-1)$, where

H = height of cave
K = bulking factor
m = height of cavity

Tests conducted by the lessee indicate a bulking factor of 1.3. The extraction height within the Boies Bed is approximately 26 feet. Since the Boies Bed contains approximately 20 percent insoluble material, the lower part of the cavity would fill with insolubles as they settled out. The effective height of the cavity would therefore be approximately 16 feet. Using these numbers, the above formula predicts a total caving height of 53 feet (Figure 4-1). This would place the predicted upper limit of the caving near the boundary of the dissolution surface but over 400 feet below the Mahogany Zone. It would be reasonable to assume that caving would occur through the dissolution surface into the lowest portion of the leached zone. Rock quality in these zones would be significantly reduced; however, no adverse impact is expected on the rock quality of the Mahogany Zone because of caving.

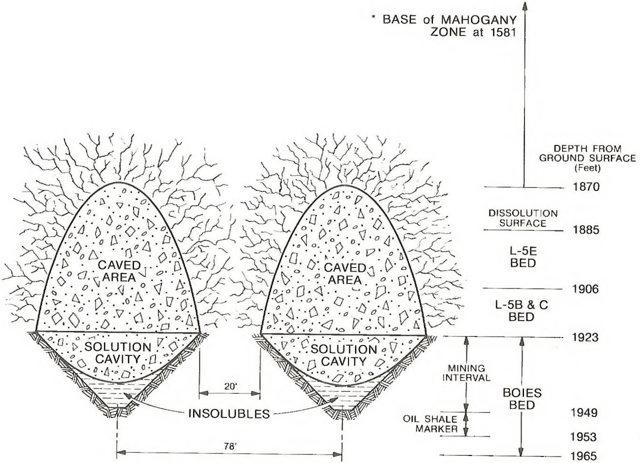
Caving is expected to occur in a gradual manner. As the cavity developed and the roof span increased, stresses in the roof rock would also increase. The nature of the bedded strata would probably result in slabs of roof rock falling into the cavity over a period of time. A rapid roof collapse would probably not occur over a short span of time (several hours).

Pillars between cavities are expected to be trapezoidal in cross section, with the tops of the pillars being much narrower than the bottom. The loading on the pillars would cause some crushing (failure) at the tops of the pillars. The lessee estimated a total downward movement of less than 1 foot. This movement would cause subsidence of overlying formations, with the potential of reaching all the way to the surface. Some movement within the Mahogany Zone would be expected; however, there should not be significant fracturing within the Mahogany Zone. Rock quality within the Mahogany Zone should not be significantly reduced. Significant fracturing could occur in the strata immediately overlying the cavities up into the leached zone. Well spacing between cavities would be sufficient to ensure that the 20-foot width at the top of the pillars would be maintained. The plan, as originally submitted, called for a cavity height of 23 feet and well spacing of 72 feet. Since the mining height has been increased to 26 feet, the well spacing would have to be increased to at least 78 feet to maintain the same width at the top of the cavity pillars. (Assuming cavities develop with the geometric configurations shown in Figure 4-1.)

The analysis indicated no impact to rock quality of the strata beneath the Boies Bed.

The lessee also proposes increasing well spacing within a cavity from 300 feet to as much as 600 feet. This should have little effect on overall ground stability. The total amount of material within pillars available to support the overlying formations would be reduced by a very small amount (less than 2-3 percent).

Engineers from the Bureau of Mines Research Center in Denver, Colorado, reviewed the proposed plan of operations and corresponding rock mechanics information. In general, they concurred with the assumptions made and conclusions reached regarding impact to overlying formations, particularly the Mahogany Zone. However, as discussed under the No Action Alternative, the impacts predicted by the rock mechanics analysis have not been measured under actual field conditions. Therefore, monitoring would be required to determine the actual impact of solution mining, including determination of cave zone height, actual impact on the Mahogany Zone because of caving and/or pillar failure, surface subsidence, and ability to control cavity configuration. When production from a cavity meets the calculated production based on the assumed cavity configuration, production from that cavity would be stopped. This would help ensure that adequate pillars remain to support the overlying formations.



End View Solution Cavity Configuration After Caving (Idealized)
FIGURE 4-1

4.2.2.3 50,000 TPY Alternative

The only difference between impacts in this alternative and those described under the Proposed Action would be the areal extent involved. The production area (i.e., well field) under the Proposed Action would involve approximately 215 acres; this alternative would involve only 90 acres, each at the end of 30 years.

4.2.2.4 500,000 TPY Alternative

In this alternative, the areal extent of the production field would be 802 acres (at the end of 30 years); otherwise, all impacts would be the same as those described in the Proposed Action.

4.2.2.5 Boundary Pillars

Section 2(p) of the lease requires that where the minerals are taken from the earth in solution that ". . . the location within a producing formation of an entry, well, or opening for extraction shall not be within 500 feet of the boundary line of leased lands without the permission of or unless directed by the lessor, nor shall induced fracturing extend to less than 100 feet from that boundary line." Wolf Ridge Corporation (WRC) is requesting in its mine plan that this 500-foot buffer width be entirely eliminated in the case of a boundary separating two contiguous leases. They also request that the buffer width be dropped to 50 feet along outside lease boundaries.

The primary reason for leaving a buffer pillar between leases is to protect one property from being adversely impacted by the mining activities of an adjoining property. However, maximum recovery of the mineral resource would be enhanced if these boundary pillars were eliminated or reduced as much as possible. In the case of boundaries separating two adjacent leases, which are both under the control of WRC, maximum recovery of resource as well as the most efficient mine layout would be served by eliminating the buffer pillar entirely. No barrier pillar between contiguous leases would be required provided a single operation were being used to develop both leases. The 500-foot buffer width requirement for outside lease boundaries will be maintained. Although this distance is probably excessive, it would remain in effect until the lessee could demonstrate the ability to control cavity configuration and determine the ultimate extent of the impact of solution mining on the rock quality of overlying formations. At that time BLM would review the 500-foot buffer requirement and make an adjustment, if appropriate.

4.3 Mineral Resources

4.3.1 Fluid Minerals

No direct impacts to the potential oil and gas resource would occur under the Proposed Action or alternatives, since it is located far beneath the sodium mining zone. The physical "on-the-ground" presence of a sodium project, however, could potentially complicate future oil and gas development in regard to locating oil and gas well pads, pipelines, and ancillary facilities.

Mined-out cavities and potential subsidence could also affect future oil and gas drilling within the sodium well field. The possible effects would be lost circulation, sticking of the drilling string, loss of borehole and inability to drill through the mine cavities, and additional casing requirements through the cavity or the rubble zone caused by subsidence. Present drilling conditions are already bad, because of the current abundant lost circulation zones and the large sections of very poor rock quality that already exist. However, with current drilling technology, if the driller were aware of the location of the cavities and/or rubble zones, these impacts could be alleviated. As such, mitigation requiring that the sodium lessee map the mined-out cavities and identify subsidence areas would be applied.

Surface and subsurface impacts, as described above, would potentially complicate future oil and gas development, but would not preclude such development nor directly affect the oil and gas resource.

4.3.2 Solid Minerals

4.3.2.1 No Action Alternative

Oil Shale

Insignificant direct damage to overlying oil shale resources will occur as a result of drilling (i.e., the portion of rock that is drilled out will be destroyed or removed). If wells are properly constructed and properly abandoned, this damage will be more than offset by the information on the oil shale that will be obtained from the drill holes.

No adverse impact is expected on the quantity, quality or future recoverability of the overlying oil shale; however, monitoring of the sodium cavities and overlying formations will be required to confirm this prediction. No impact to the oil shale resources below the Boies Bed is expected.

Sodium Minerals

Sodium minerals mined from the Boies Bed will be consumed, which is a direct impact to the sodium minerals. The remaining Boies Bed sodium resource will be left as pillars to control subsidence and, therefore, potentially foregone. The knowledge gained as a result of the pilot project about the sodium resource and the proposed mining and processing method is of sufficient benefit to justify the extraction.

Sodium resources within a small part of the the L-5E Bed could be impacted if the cavity roofs collapsed. The thickness of this bed and its proximity to the dissolution surface, however, make it doubtful that future recovery of this sodium would be possible.

4.3.2.2 Proposed Action

Oil Shale

As in the No Action Alternative, there would be some damage to oil shale resources because of drilling. The existence of wells within the Mahogany Zone throughout the project area could cause some inconvenience for future recovery by conventional means, especially if the wells were not abandoned properly. To ensure that there were no open voids left across the Mahogany Zone (where the potential exists for gas to accumulate inside or outside the casing), the entire zone would be plugged with cement upon well abandonment. As discussed in the rock quality section, no significant impact is expected on the quantity, quality, or future physical recoverability of the overlying oil shale as a result of caving or subsidence; however, monitoring would be required, as described in Section 4.2.2, to verify this prediction. No impact to the oil shale resources beneath the Boies Bed is expected.

Sodium Minerals

Figure 4-2 shows a typical cross-section of the Boies Bed in relation to the dissolution surface in the project area. The targeted mine zone is that portion of the Boies Bed (nahcolite facies only) lying above the oil shale marker to the contact with the L-5B and C beds, a height of approximately 26 feet. Within this mining interval, recovery of nahcolite would be about 40 percent. The remaining 60 percent of the mining interval left for subsidence control would probably not be recoverable in the future. The proximity of the Boies Bed to the dissolution surface makes it doubtful that recovery by conventional mining methods would be feasible. It is also doubtful that the remaining Boies Bed below the oil shale marker (3 to 4 feet) would be suitable for future recovery. Its proximity to the overlying cavities as well as its small thickness would reduce the technical and economic feasibility of recovering this zone. Sodium resources within the L-5E Bed could also be impacted if the cavities collapsed. The thickness of this bed and its proximity to the dissolution surface, however, make it doubtful that future recovery of this sodium would be possible.

4.3.2.3 50,000 TPY and 500,000 TPY Alternatives

As discussed in the rock quality section, the only difference between the impacts on minerals in these alternatives versus the Proposed Action is the areal extent of the proposed well fields.

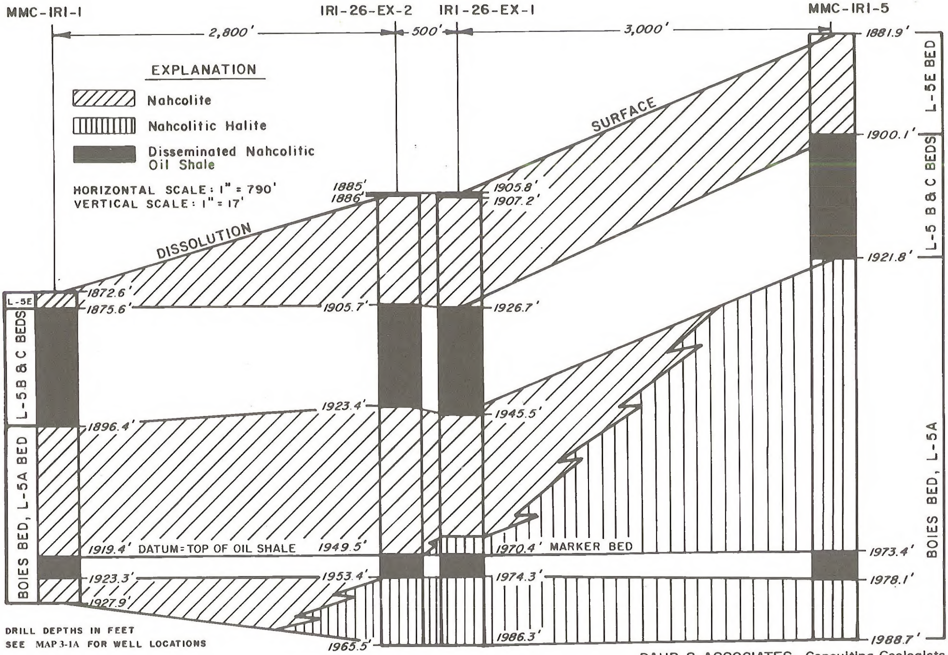
4.4 Water Resources

4.4.1 Surface Water Quantity

The consumptive use of water under the Proposed Action or project alternatives would affect the quantity of water available from Yellow Creek and Piceance Creek for other uses. Water would be used for production, processing, domestic purposes, and for the filling of the mine cavities after mining has been completed. The void spaces left by removal of the sodium would be filled with briney water. Water would be supplied by groundwater from a well located in Township 1 South, Range 98 West, Section 24, NE1/4 NE1/4. The company currently has conditional water rights for 2,235 gallons per minute from this well. This well would produce 300 gallons per minute, which is sufficient to supply all needs, except for the water requirements of the 500,000 TPY Alternative. Additional water needs required by this alternative would have to be supplied from a yet to be identified source. WRC has conditional water rights for an additional 15,645 gallons per minute from other wells in the area. The total water usage would vary by alternative, see Table 4-3.

Wright Water Engineers conducted hydraulic simulations to determine surface water impacts associated with the pumping of the water supply well (Table 4-3). The pump rates, also shown in Table 4-3, would cause a reduction of average daily flow in Yellow Creek of 2 percent (.04 cfs) for the 50,000 TPY Alternative, 5 percent (.09 cfs) for the Proposed Action (125,000 TPY), and 23 percent (.41 cfs) for the 500,000 TPY Alternative. Piceance Creek would be depleted by .1 percent (.04 cfs) for the 50,000 TPY Alternative, .4 percent (.15 cfs) for the Proposed Action (125,000 TPY), and 2 percent (.71 cfs) for the 500,000 TPY Alternative. These reductions would take place gradually, with full depletion at the end of mine life. These depletions could persist for as long as 20 years after pumping stopped.

The depletion amounts shown in Table 4-3 are based on mathematical modeling of the hydrologic system. The effects to stream flow in the Yellow and Piceance creeks from pumping groundwater could be less than Table 4-3 figures show; however, effects probably would not be greater (Wright Water Engineers 1985).



HORIZONTAL SCALE: 1" = 790'
VERTICAL SCALE: 1" = 17'

DRILL DEPTHS IN FEET
SEE MAP 3-1A FOR WELL LOCATIONS

DAUB & ASSOCIATES, Consulting Geologists
Grand Junction, Colorado

Stratigraphic Cross-Section MMC-IRI-1 to MMC-IRI-5,
Dissolution Surface to Base of Boies Bed.

FIGURE 4-2

TABLE 4-3

WATER QUANTITY EFFECTS

	No Action	50,000 TPY	Proposed Action	500,000 TPY
Pumping Rate (gpm)	60	80	150	600
Annual Water Use (acre-ft) [a]	93	124	232	928
Total Use for Mine Life (acre-ft)	186	3,720	6,960	27,840
Water Left in Cavities (acre-ft)	13	574	1,404	5,615
Water Left in Cavities with Subsurface Fly Ash Disposal (acre-ft) [d]	13	574	1,404	5,488
Depletion in Flow from Yellow Crk (cfs)	None	0.04 [b]	0.09 [c]	0.41 [c]
Percent of Average Daily Flow	None	2	5	23
Depletion in Flow from Piceance Crk (cfs)	None	0.04 [b]	0.15 [c]	0.71 [c]
Percent of Average Daily Flow	None	0.1	0.4	2

[a] Assumes pumping at specified rate for 24 hours per day, 350 days per year.

[b] Assumes that 50 percent of the pumping will be stream depletion and that the effect will be evenly divided between Piceance and Yellow Creek.

[c] Stream depletion after 30 years of pumping modeled by Wright Water Engineers (1986).

[d] Fly ash disposal is considered under the 500,000 TPY Alternative only.

No springs would probably be affected under any alternative. The water supply south of the leases might be within the cone of depression created by pumping of mine water supply well(s). This could require deepening of this off-site well. WRC is required by state law to mitigate impacts to vested water right holders, which could include deepening the well.

Because the surface water system in the Piceance Basin is overallocated, any depletion in surface water flow would be considered significant. State law requires that adverse effects to other water users be mitigated through a water augmentation plan. This requirement will be administered by the state of Colorado.

4.4.2 Surface Water Quality

Surface water quality could be degraded by an increase in sediment delivered to the stream associated with sodium project construction/operation or by a spill of brine from mine operations. Fuel spills could also occur during refueling operations.

The mine site is located at least 2 miles of ephemeral stream distance from any perennial water. The interim revegetation standards proposed in the reclamation section should also quickly stabilize the soils. It is, therefore, unlikely that any significant increase in sediment yield would occur in either Yellow or Piceance creeks.

The mine operator has proposed to install leak detection alarms on all surface piping. Also, the piping has been designed so that it can be drained to the evaporation ponds before it is moved. Visual inspections of the piping system are also planned. These precautions would limit any leaks of brine from the piping to small amounts. The mine facilities would be built on concrete slabs and drained via a sump system to the evaporation ponds. This would effectively contain any spills in the plant. Use of proper procedures would limit spills of fuel to insignificant amounts.

Degradation of surface water quality from brine spills would only take place if the evaporation ponds leaked or overflowed. The evaporation ponds have been designed with dual liners and a leak detection system, and leaks that were detected would be repaired. No spills would occur if adequate excess storage was maintained in the ponds. During exceptionally wet weather (less frequent than the 100-year event) when there is no effective evaporation, the ponds could overtop, releasing fluids to Yellow Creek. This potential impact would be mitigated by requiring that the evaporation ponds be maintained with adequate free board. This could be accomplished by enlarging the ponds, placing the waste water in other locations, or using waste heat from the mine to increase the rate of evaporation in times of exceptionally wet weather.

Solids periodically would be removed from the evaporation ponds and hauled to an approved landfill for disposal.

Consideration was given to alternative methods of waste water disposal. Hauling all waste water from the mine site would eliminate the need for evaporation ponds. Disposal of the water hauled from the mine could be accomplished by alternative methods such as deep well injection, evaporation, or cycling through a water treatment facility. All of these alternatives would require more energy than on-site disposal. They cannot be fully analyzed because alternate facilities do not exist; however, the impacts associated with these alternative methods would be similar to the impacts of the proposed on-site facilities, except that water treatment facilities are generally designed to remove organic pollutants but rarely are designed to remove salts. Based on these concerns, there probably would be no benefit gained from requiring the off-site disposal of waste water. There would be a small benefit to allowing the on-site disposal of waste water, because less energy would be used by on-site evaporation, and potential impacts would be localized.

In summary, the risk of significant impacts occurring to surface water quality would be very low if the mine was operated as planned. This low risk would be further reduced by requiring that the evaporation ponds be maintained with adequate free board. As such, there should be no significant impact to surface water quality under any of the alternatives.

4.4.3 Groundwater Quantity

Groundwater quantity would be directly affected by the pumping of water from the upper aquifer. The amount of water removed from the upper aquifer by alternative is shown in Table 4-3. This would be an insignificant percentage of the amount of groundwater in storage for all alternatives. It might require from 5 to 50 years from the end of the project life for the aquifer system to recover and to fully replace, through natural recharge, the amount of water removed from storage during sodium mine operations.

4.4.4 Subsidence Effects on Quantity and Quality

4.4.4.1 Common to All Commercial-Scale Alternatives

Subsidence caused by the mining of the sodium could change the vertical hydraulic conductivity of the aquifer systems. This potential effect was investigated in a report for the applicant by Weston (1985). This report projected that the hydraulic head of the perched aquifer above the upper aquifer would drop by 30 feet, and the hydraulic head of the upper and lower aquifers would raise by about 3 feet (Weston 1985). These effects would cause a mixing of the aquifers. Because the quality of the perched aquifer and the upper aquifer is similar, this mixing would be insignificant. The mixing of the upper and lower aquifers would not be significant because there appears to be already significant hydraulic connection between the two aquifers and the quality of the water at the base of the upper and top of the lower aquifers is similar. Also, the hydraulic gradient between the two aquifers is from the upper aquifer to the lower aquifer. Should the hydraulic connection between the two aquifers be increased, the quality of the water in the upper aquifer should not be adversely affected and the quality of water in the lower aquifer could be marginally improved.

The Weston report (1985) assumed that the worst case hydraulic effects of subsidence would be very large. The hydraulic effects of subsidence would probably not be as large as those projected by Weston, because the high kerogen content of some of the rock layers (such as the Mahogany Zone) that lie above the mining zone gives the rock plastic properties, which make the rock somewhat resistant to fracturing (Weeks et al. 1977). Therefore, subsidence impacts would not be as severe as projected by Weston.

Based on an aquifer test conducted on the sodium lease property in 1981 the Weston report (1985) assumed that communication through the Mahogany Zone exists at the mine site. The test results also indicated that the Mahogany Zone allows communication between the two aquifers (Weston 1984). The difference in hydraulic head between the two aquifers is less at the well field than at the location where the test was conducted. This may mean that there is more communication between the upper and lower aquifers at the well field than at the test site. Subsidence could still increase the communication between the two aquifers. Although this could lower the head of the upper aquifer and raise the head of the lower aquifer, there would be no loss of water as a result. A significant reduction in water quality would not result from increasing the rate of hydraulic flow across the Mahogany Zone under any alternative.

The "rubber beds" are thin (2-3 feet thick) beds of very high yield oil shale that behave plastically and swell when brought to the surface. Experience obtained during drilling indicates that these beds would probably seal small (1 millimeter or less) cracks in the rock by swelling into the crack. The beds appear to be continuous over the area of the well field. Although the beds probably would have some mitigative effect, because they are not very thick, they would probably not be effective at sealing the mine cavities from the base of the lower aquifer if roof failure occurred.

4.4.5 Groundwater Quality

4.4.5.1 Common to All Alternatives

The most significant potential impact to water resources from the sodium mine operations would be to groundwater quality. This impact could occur as a result of brine leaking through well casings or through breaching of a solution cavity during collapse of the mine zone. There is also the slight potential that the perched aquifer would be contaminated by percolation from the septic system leach field. Because the permeability of the Uinta Formation is low and the distance from the leach field to water in the perched aquifer would be 300 to 400 feet, the risk of contamination is very low. This potential impact would not be significant.

Contamination of the aquifers could also occur from breaching of a well casing because of corrosion or improper installation. If this happened, saline brines could leak into the groundwater system. The leak detection system designed for the production wells should detect any leak in excess of 3 gallons per minute (Jones 1985). If a leak were detected, use of the well would be suspended until repaired, and significant impacts to the quality of the groundwater should not occur.

A undetected leak (less than 3 gpm) in the upper part of the casing would also be invisible to the groundwater monitoring system, because the hydrologic monitoring program proposed by the applicant would only measure the lowest groundwater zone. Over the life of a cavity, this could cause the introduction of a significant amount (about 1 acre-foot) of brine into the groundwater system. This potential impact would be mitigated by requiring that two groundwater zones be monitored (the B-Groove and 50 feet above the base of the dissolution surface). This would ensure that all casing leaks were detected and that remedial actions, such as well repair, could be taken before significant impacts to groundwater quality occurred.

Significant impacts to groundwater quality could also occur as the result of the collapse of the roof of a mine cavity. In this case, the collapse zone could extend through the base of the lower aquifer and communication would be established between the relatively fresh water in the lower aquifer and the brines in the mine cavity. This could significantly degrade the quality of the water in the lower portion of the lower aquifer. The roof of the mining zone would probably collapse under a commercial-scale mining operation (see Rock Quality section). The collapse zone would probably extend to 53 feet above the cavity, and physical connection between the lower aquifer and the brines in the cavity would be established. WRC believes, that the likelihood of a physical connection occurring between the mine zone and the groundwater system would be low because of the presence of the "rubber beds" and competent oil shale between the mine zone and the base of the aquifers. This would probably be true if the no roof did not collapse; however, this analysis assumes that roof collaspe would take place over all cavities under commercial-scale development.

If this occurred, the brines would naturally tend to remain isolated from the relatively fresh water in the lower aquifer, because the brines are more dense and more viscous than the relatively fresh water. Also, if hydraulic communication were established between the mine cavities and the lower aquifer, there would no longer be a smooth gradient at the base of the aquifer. Each collapsed cavity would be a steep sided basin in the base of the saturated zone, causing the brines to remain ponded in the cavities and the fresh water would tend to float on top of the brines. Mixing would occur only at a very slow rate. The dominant mixing process would probably be diffusion, which would tend to make the brines more fresh and the relatively fresh water more saline. This process would tend to be counter-balanced by the segregation of materials of different density by gravity. The diffusion process and other processes operating at the base of the lower aquifer take place at very slow rates.

If the cavity roof gradually failed, degradation of the quality of the lower aquifer would probably take place so slowly that it could not be detected by existing technology.

More significant impacts to the quality of the lower aquifer would occur in the unlikely event of a catastrophic or rapid roof collapse. This would take place over several hours and would be fast enough to cause turbulent flow in the base of the aquifer system. This turbulent flow could cause the mixing of the relatively fresh water of the lower aquifer with the saturated brines in the cavity. These brines could have a TDS of as high as 100,000 mg/l. Over the very long term (200 to 1,000 years) this could cause an increase in salt load to the White River by as much as 1.5 mg/l or 1 percent for the 500,000 TPY Alternative. If, however, the brines are diluted as they move through the system, no increase in salt load would occur.

If the groundwater monitors detect brine entering the groundwater system, the brines will have to be contained within the boundaries of the lease or remedial action will be required. These remedial actions will have to be designed to isolate the brine from the rest of the aquifer system. A technique that may be used is the pumping of the brines for surface disposal. The number of permanent groundwater monitoring wells needed will vary by alternative, depending on the size of the well field.

The analysis presented here is based on the assumption that the dissolution surface is a dynamic feature and that the solution of nahcolite is an active natural process in the Piceance Basin. The alternate assumptionis that the dissolution surface is a stable feature and only minimal nahcolite solution is presently taking place. If this is correct, there is the low possibility that the stability of the dissolution could be upset and a (new epoch of nahcolite solution would be initiated). If this were to happen, the long-term impact to the quality of the lower aquifer could be much greater than those projected here. There is a low probability that this scenario would occur.

4.4.5.2 No Action Alternative

Only up to three cavities will be constructed under the No Action Alternative. The groundwater monitoring system required for the pilot plant should detect any significant amount of brine entering into the groundwater system in sufficient time for remedial action to be taken. Therefore, no significant impacts to groundwater quality will occur under this alternative.

4.4.5.3 Proposed Action

The major difference between the alternatives as they potentially affect groundwater quality would be the number of cavities constructed by each alternative. Under this alternative, 330 cavities would be mined. Also, there would be a greater number of cavities that could fail.

If all of the cavities collapsed, the area at the base of the aquifer in contact with salt would increase by about 20 percent within the leases; however, this would only be about a 1 percent increase over the total area of the base of the groundwater system that might be in contact with salt. This could result in an increase in salt concentration in the lower portion of the lower aquifer within the vicinity of the leases. This would be locally significant but not regionally significant.

4.4.5.4 50,000 TPY Alternative

Under this alternative, 135 cavities would be mined over the project life. If all of the cavities collapsed, the area at the base of the groundwater system in contact with salt would increase by about 10 percent within the leases; however, this would only be about a .5 percent increase over the total area of the base of the groundwater system that might be in contact with salt. This would not be significant.

4.4.5.5 500,000 TPY Alternative

Under this alternative, there would be the greatest risk that an impact to the quality of the groundwater could occur, because of the larger number of cavities that would be mined (1,320) and because the well field extends to the boundary where the Boies Bed is truncated by the dissolution surface. In this area, which is to the southwest of the plant site, the base of the groundwater system intersects the mine zone. This means that any roof collapse, even of a few feet, could establish a hydraulic connection between the relatively fresh water of the lower aquifer and the brines of the cavities.

If all of the cavities collapsed, the area at the base of the groundwater system in contact with salt would increase by about 80 percent within the lease boundaries; however, this would be only about a 4 percent increase over the total area of the base of the aquifer that might be in contact with salt. This could result in an increase of salt concentration in the lower portion of the lower aquifer within the vicinity of the leases. This would be locally significant but not regionally significant.

Under this alternative, coal would be used as an energy source. This would generate fly ash, which would require disposal. Two proposals have been made for fly ash disposal: disposal on the surface in clay lined pits or pumping the fly ash into completed mine cavities.

The first method would effectively isolate the fly ash from the hydrologic system. Over the very long-term (5,000 plus years), this material could be exposed by erosion. The pile could then cause adverse impacts to the surface water quality. The second method would displace water from the mine cavities, reducing the amount of brine underlying the groundwater system. Generally, either method of fly ash disposal would be unlikely to cause significant environmental impacts; however, disposal of fly ash in abandoned mine cavities could generate some small benefits to the environment. Based on this, subsurface disposal of fly ash would be preferred.

4.5 Soils

The effect on soils would be the same for all alternatives. All surface soils and varying amounts of subsoil and all plant nutrients would be disturbed or displaced by the handling and processing plant and associated facilities. Loss of some soil would occur on disturbed areas because of wind and/or water erosion. Wind and/or water erosion would also occur on topsoil stockpiles until they were adequately stabilized. Compaction, caused by stripping, stockpiling and redistribution of soil material, would reduce soil water infiltration rates and volume. The stripping, stockpiling, and redistribution of the soil would also result in intermixing of soil profiles, causing a subsequent lowering of soil fertility levels and reduced productivity that would affect diversity of reestablished vegetative communities. Intermixing could be reduced through the use of a more detailed soil survey before stripping. Committed mitigation, which includes reclamation measures for vegetation and soils, would cause the above effects on soils to be insignificant.

Spills of nahcolite pregnant solution could occur from pipeline ruptures or during pipeline disconnection and movement to new production well pairs. Surface spillage of nahcolite would result in dispersion of soil particles and subsequent breakdown of soil structure. Therefore, moisture infiltration would be reduced and the increased sodium content would raise the osmotic potential of the soil water solution, making it more difficult for water to move into and through the soil. This would create soil drought conditions and vegetation would undergo physiological drought reactions. The overall impact on soils from possible nahcolite spillage would be insignificant; however, vegetation and reclamation efforts could be significantly affected. Given the surface reclamation measures identified in Section 4.7 and the expected small size of such spills, the overall impacts on soils and associated vegetation would be insignificant for all alternatives.

Although the effect on soils would be the same for each alternative, the degree of impact would change under each alternative. Table 4-4 identifies the acreage of each soil type impacted by each alternative.

TABLE 4-4

AFFECTED SOIL MAPPING UNIT BY ALTERNATIVE

Soil Mapping Unit Symbol	Soil Mapping Unit Name	No Action	Proposed Action	50,000 TPY	500,000 TPY
33	Forelle loam	3			
64	Piceance fine sandy loam	6	49	23	151
70	Redcreek-Rentsac complex	2	27	1	15
73	Rentsac channery loam	6	109	56	523
75	Rentsac-Piceance complex	3			79
104	Yamac loam	23	27	38	192
	Total Acres	43	257	118	960

4.5.1 Prime and Unique Farmlands and Statewide Important Farmlands

All alternatives would have the same impact. In the unlikely event that nahcolite contaminated water from the project area entered the drainage system, the farmlands approximately 5 miles downstream along Yellow Creek might be significantly impacted. On a regional basis, this impact would be of minor significance if the prime farmlands along the White River remain unaltered.

4.6 Vegetation

For all alternatives, reclamation efforts would return the disturbed areas to production levels equal to or greater than before disturbance. The time frames for achieving these standards would vary, depending on the vegetative type. The sagebrush/grass vegetative type might require 4 to 8 years to return forage cover and production equal to that existing before disturbance. The pinyon-juniper vegetative type would require 100 to 150 years to achieve tree cover comparable to that before disturbance. Herbaceous forage production would exceed that present on existing pinyon-juniper communities. The hillside bunchgrass vegetative type might require 2 to 5 years to attain cover and production of that before disturbance.

Species composition on reclaimed sites could differ from the plant communities present before disturbance. This difference would be dependent on the following: species planted ("native" versus "nonnative"); changes in slope and aspect as a result of grading; addition of fertilizers, mulches, and herbicides; topsoil conditions; and postreclamation uses. Over time, the reclaimed areas would more closely represent the predisturbance condition as a result of native species invasion from surrounding undisturbed areas and soils development. Some areas, however, would never closely resemble the present plant communities, particularly the pinyon-juniper community. No significant adverse impacts would occur to the forest resources from any of the alternatives.

The effect on vegetation would be the same for all alternatives. Vegetative production would be eliminated for the life of the projects on the handling and processing facilities. Construction of new well pairs, pipelines, and access roads would be an ongoing process, as would the revegetation of mined-out well pairs and ancillary facilities. Reestablishment through invasion of native plant species on reclaimed sites would be enhanced because of the large "edge effect" of the development design. Dust generated by vehicular traffic on access roads within the well field would affect the adjacent vegetation to a minor degree. The primary effect would be decreased palatability of forage to livestock and wildlife, and the secondary effect would be decreased productivity. Committed mitigation, which includes reclamation measures for vegetation, would cause the above effects to be insignificant.

Although the effect on vegetation would be the same for all alternatives, the degree of impact would change by the number of acres involved under each alternative. Table 4-5 shows the acreage of each vegetative type that would be affected by each alternative.

During the short-term, vegetation on 43 to 960 acres of land, depending on the alternative, would be lost to surface disturbance. In the long-term, vegetation would be replaced with forage production equal to, or potentially better than, what existed before disturbance. Plant species would differ from the plant communities present before disturbance, with subclimax community composition being dependent on sitecharacteristics, seeded species, cultural amendments, and postmining management practices.

TABLE 4-5

AFFECTED VEGETATION TYPE AND ACREAGE, BY ALTERNATIVE

Alternative	Mid Elevation Sage	Low Elevation Sage	Pinyon-Juniper	Hillside Bunch	Total
No Action	25	13	5		43
Proposed Action	75	44	138		257
50,000 TPY	28	17	73		118
500,000 TPY	347	165	447	1	960

Development of sodium, depending on the alternative, would disturb between 43 and 960 acres. In addition, up to 50,000 acres could be disturbed regionally because of the development of the oil shale resource. The potential impacts would be primarily within the sagebrush and pinyon-juniper vegetative types. These two cover types account for 42 and 28 percent of the plant cover types within the Piceance Basin Planning Unit. On a regional basis, these cover types would not be significantly impacted by the Proposed Action or alternatives.

4.6.1 Threatened, Endangered, Candidate, and Sensitive Plant Species and Remnant Vegetation Associations

No federally listed threatened, endangered, candidate, or sensitive plant species would be directly affected by any of the alternatives.

Approximately 35 of the 45 acres within the remnant vegetation association (RVA) would be disturbed by the Proposed Action or 50,000 TPY Alternative. This represents 78 percent of the RVA and would essentially eliminate the value of the area for future studies and comparisons. This would be a significant impact to this specific population but would not be a significant impact to the general plant association because of its common occurrence in the area.

As a result of the 500,000 TPY Alternative, approximately 40 of the 45 acres within the RVA would be disturbed. This would represent 89 percent of the RVA and would essentially eliminate the value of the area for future studies. This would significantly affect this individual population but would not significantly impact the general plant association because of its common occurrence in the area.

4.7 Reclamation

The two dominant vegetative/soil types that would be affected by the proposed project and alternatives have low to fair reclamation potential. These are the low elevation pinyon-juniper/shallow very gravelly sandy loams and mid-elevation big sagebrush/moderately deep loams (Tiedeman and Terwilliger 1978; phyto-edaphic units 4 and 11). These phyto-edaphic unit classifications correspond to the pinyon-juniper woodland and big sagebrush shrubland vegetative communities described in Section 3.6, and to the Rentsac channery loam soil, Piceance fine sandy loam soil, and Yamac loam soil described in Section 3.5.

The low elevation pinyon-juniper/shallow very gravelly sandy loam association has low reclamation potential and soil fertility, primarily because of conditions of shallow depth to bedrock (less than 10 inches) and high gravel content. Low infiltration and high runoff make erosion a critical hazard, unless the soil surface has been stabilized.

The mid-elevation big sagebrush/moderately deep loam has fair reclamation potential. High exchangeable sodium percentages at depths of 30 to 40 inches would seriously limit plant growth if such material were brought to the surface or mixed with topsoil material. The soil surface can become very dusty and, once disturbed, is very susceptible to severe wind erosion. This dry, floury soil material provides a poor seedbed in terms of seedling establishment, unless stabilized.

Unsuccessful rehabilitation of disturbed lands because of low reclamation potential and/or inadequate reclamation techniques would result in long-term suppression of soil productivity on respective soil associations described above. Successful reclamation of low-intensity soil disturbance on both soil associations has been locally demonstrated on three on-lease core hole pads seeded by Multi-Mineral Corporation in 1981. The results of this reclamation effort indicates that adequate top soil fertility exists with which to achieve successful reclamation on the facility and well field sites.

Postmine land use and reclamation emphasis would be oriented toward restoring crucial big game winter habitat and livestock range. In an effort to encourage the development of a rangeland community best meeting these dual objectives, cultural practices that would favor the initial establishment and eventual survival of nongrass forms should be employed (compensation for grasses competitive advantage). Specific cultural practices that favor forb and shrub establishment include, but are not limited to:

—Using legume seed preinoculated with proper Rhizobium bacteria.

—Ensuring use of site adapted seed.

—Refraining from fertilization during seedling establishment.

—Satisfying specific stratification requirements of seeded species.

—Planting seed using optimal application methods, at optimal depths and time of year, depending on species-specific requirements.

In order to optimize reclamation success and ensure effective stabilization of disturbed soils, reclamation must proceed at the same average rate as well field development, and well field disturbances must be minimized to the greatest practical extent. This would serve to reduce soil erosion losses associated with developmental stages of reclamation and increase the interspersion of unaltered native vegetation within reclaimed areas. Maximizing the distribution of unaltered vegetation within the well field would complement rehabilitation efforts by providing natural erosion (wind and water) control buffers and would facilitate seed dispersion from native sources.

Topsoil handling methods could also have an important influence on ultimate reclamation success. As proposed by the applicant, about 45 percent of all well field disturbance would be attributable to topsoil stockpiling (300-foot spacing). Even relatively short periods of topsoil stockpiling could result in significant declines in soil fertility through the processes of erosion and nutrient leaching and mortality of beneficial soil microorganism populations. An alternate means of topsoil handling would involve stripping topsoil from newly constructed well pads and immediately reapplying this material to abandoned areas that have been recontoured and were ready for reclamation. The advantages of this system include reducing well field disturbance by up to 45 percent, preserving the potential for vegetative and seed propagation of native vegetation, and avoiding declines in the productive potential of soils associated with stockpiling. It could substantially reduce reclamation costs by helping to circumvent efforts expended in soil testing, application of soil amendments, seedbed preparation, and reseeding.

BLM believes that successful reclamation could be attained through adherence with applicable reclamation procedures and appropriate monitoring, as presented in Section 2.4.1.

4.8 Livestock Grazing

The effect on livestock grazing would be the same for all alternatives. The principal impact would be the direct loss of forage production from the areas involved with the handling and processing plant, roads, pipelines, active well pairs, and reclaimed areas fenced to protect new vegetation. An indirect impact would be reduced forage palatability as a result of vehicle generated dust. The loss of forage production would result in less animal unit months (AUMs) of forage available for livestock grazing. The short-term loss of these AUMs under each alternative would be insignificant, as reclamation would equal or increase forage production of the existing plant communities in the long term. Increased forage production, if realized, would result in a proportionate increase in livestock grazing potential.

Although the effect on livestock grazing would be the same for all alternatives, the degree of impact would change, depending the number of acres involved under each alternative. Between 43 and 960 acres would be affected, depending on the alternative. The number of AUMs that would be affected by each alternative are:

Alternative	AUMs
No Action	3-6
Proposed Action (125,000 TPY)	4
50,000 TPY	2
500,000 TPY	10

All impacts to range improvements would be mitigated, resulting in insignificant impacts under each alternative.

There would be no effect on wild horses from any of the alternatives.

This project, in conjunction with all other projects in the Piceance Basin, would have minimal impacts on the total amount of livestock grazing now taking place in the Piceance Basin.

4.9 Wildlife

4.9.1 Big Game

The only species of big game that would experience notable loss of occupied habitats and would be frequently influenced by solution-mining operations would be mule deer.

Throughout the operational life of the mine, every alternative would involve direct removal of mule deer winter range habitat (Map 3-5, Chapter 3). These impacts would persist until mine developments no longer occupied suitable acreage and subsequent reclamation restored a productive woody vegetative community (winter forage should be generated within 5 years following reclamation).

A potentially significant impact to wintering deer populations would involve indirect habitat loss, which would result from avoidance of areas frequented by human activity. Depending on the intensity and frequency of disturbances, deer make little or no use of available forage and cover resources adjacent to sources of disturbance, thereby reducing the overall capacity of the range to support former deer use. Incidental observations of deer response to development activities in Piceance Basin indicate that deer tend to remain several hundred feet from stationary high-use activity. For purposes of this analysis, it is assumed that 50 to 100 percent of the deer normally wintering in the project area would refrain from making appreciable use of the area within 300 feet of the well field operations and access road and within 600 feet of the processing facility.

Incremental loss of high-value winter habitats in Piceance Basin, even if temporary, is considered cumulatively significant as adjacent winter use areas are occupied and increasingly affected by development. Public lands comprising Piceance Basin's mule deer winter ranges are currently capable of supporting about 26,585 deer on a sustained basis. This current carrying capacity figure is about 7 percent higher than the minimally acceptable base population of 24,900 animals jointly established by BLM and Colorado Division of Wildlife during development of the Piceance Basin Resource Management Plan (RMP) (USDI, BLM 1985a). Carrying capacity losses that exceed the threshold level could significantly reduce populations of deer wintering in the basin and defeat federal and state management objectives designed to sustain herd productivity.

Direct mortality via vehicular collision and/or poaching can represent notable forms of animal loss. Vehicle related deer kills vary annually, but in the 4-year period, 1977-1981, road segments accessing the lease area accounted for at least 800 road-killed deer. Traffic volume on affected road segments would increase with employment and production and could account for proportionate increases in baseline road-kill figures. Periods of highest road kill (mid-October to late November and early February to late April) are synchronous with migration related movement and concentrated use of sagebrush or hay bottoms. These preferred fall and particularly spring use areas are coincident with the location of major road networks. Road-kill incidents would be aggravated if, during these months, shift changes and product haulage coincided with the peak activity periods of deer (early morning, early evening). Deer losses could be minimized by providing and strongly encouraging mass transit for employees and synchronizing shift changes and haul schedules with times when deer would be less likely to be active and concentrated along major highways.

Poaching is a potentially severe problem in mining areas throughout the West. This mine situation would be subject to potential poaching problems because of large concentrations of wintering deer occurring along mine access routes. Incidents of poaching would also expectedly increase as a function of the number of personnel involved with mine construction and operation. A poaching problem could become pronounced if shift changes coincided with peak activity periods of deer during the months from October to May. Poaching could be discouraged by adopting mass transit systems for employees and prohibiting the possession of firearms in employee vehicles on tract.

"Deer-proof" fencing of evaporation ponds would effectively eliminate instances of entrapment and prevent ingestion of contaminated water.

4.9.1.1 No Action Alternative

Collective habitat/carrying capacity losses attributable to the approved pilot-scale project are extremely small and of short duration and account for about 0.5 percent of the remaining carrying capacity buffer (Table 4-6). The limited extent and duration of pilot plant activities (2 years) did not warrant the application of off-site mitigation to compensate for short-term habitat losses. Wildlife-oriented reclamation practices that were applied by BLM to the approved action were considered adequate for compensating long-term direct habitat loss.

TABLE 4-6

SUMMARY OF
MULE DEER HABITAT LOSSES

Impact	Affected Acreage by Alternative			
	No Action [a]	50,000	125,000	500,000
Direct Habitat Loss				
Life of Mine	17	74	89	149
Temporary (Well Field) [b]	1	11	26	75
Indirect Habitat Loss [c]	41	47	58	121
Total Habitat Loss [c]	59	132	173	345
Percent of Remaining Carrying Capacity Buffer [d]	0.5	1.0	1.3	2.6

[a] 2-year project, remaining alternatives reflect 30-year mine life.

[b] Average unreclaimed disturbance based on 5-year increments and considering concurrent reclamation.

[c] Instantaneous loss, average at any given time over mine life.

[d] Based on adopted carrying capacity threshold developed for Piceance Basin RMP.

4.9.1.2 Commercial Development Alternatives

Impacts associated with the commercial development alternatives would be more extensive and persistent over time. See Table 4-6 for an alternative-specific impact summary.

Permanent mine facilities would involve the direct loss of winter range habitat over the 30-year mine life and until successful habitat restoration (Table 4-6). Progressive well field development would alter existing habitat conditions at a fairly constant rate throughout mine life, with additional acres in various developmental stages of reclamation (Table 4-6). With successful achievement of reclamation goals, big game winter range utility (forage) would be regained in 5 years following initial reclamation work. Thus, in any

5-year period, reclaimed acreage should average 40 percent complete on recently abandoned portions of the well field.

Indirect habitat loss, based on the same assumptions given earlier, would result in partial or complete disuse of functional habitats surrounding active mine areas throughout the 30-year mine life (Table 4-6).

Because of the relative extent and 30 plus-year persistence of impacts associated with the commercial production alternatives, mitigation designed to offset short-term habitat losses is considered necessary. Mitigation as outlined in Section 2.7 requires the applicant to perform off-site habitat enhancement treatments at 5-year intervals throughout mine life.

The extent of enhancement practices should generally equal twice the total acreage lost over each 5-year period (Table 4-6); however, BLM would allow flexibility in project design and implementation in consideration of the actual extent of surface disturbance and current habitat needs of deer in Piceance Basin. The 5-year interval is based on the fact that generally within the first 5 years after vegetative manipulation, the quality and availability of selected plant forage increases dramatically over pretreatment levels. Deer response to these treatments follow similar trends—marked attraction and use falling to pretreatment levels in about 5 years. Since mine-related habitat loss figures assume complete loss or disuse of suitable habitats and mitigative-oriented vegetative treatments only temporarily increase the productivity of existing habitat, the factorial of two is considered reasonable and necessary to compensate for short-term carrying capacity losses.

Direct habitat losses could be reduced during well field development by making the most efficient use of disturbed acreage and minimizing the amount of disturbance necessary for setting surface pipe in "undisturbed" acreage. Live topsoil handling would significantly reduce disturbed acreage devoted to stockpiled material. Wildlife oriented reclamation procedures, as contained within Section 2.4, Mitigation, would adequately compensate for long-term habitat alteration effected by mining.

4.9.2 Raptors

Available information indicates that the entire project area supports very little raptor nesting activity. The only evidence of nesting is the one nest encompassed by the 500,000 TPY Alternative well field. Mine-related activity in close proximity to raptor nests could preclude or foil annual reproductive efforts, or result in inadvertent destruction of the nest site. If the 500,000 TPY Alternative and its associated well field were approved for development, protective measures would be implemented to prevent actual destruction of the nest and minimize degradation of nest-site conditions. Mitigation would be developed as soon as well field development schedules and configuration planning were made final by the applicant.

Unforeseen impacts to breeding raptors would probably occur during commercial-scale development, since the chances of encountering previously undiscovered or newly constructed nests would increase in direct relation to the amount of forested habitat affected and the operational life span of the mine (Table 4-7). As committed by WRC in their mine plan, inventories for raptor nest activity would be conducted in advance of small increment well field clearing. This would provide timely information necessary to develop emergency nest site mitigation and help reduce site destruction or annual reproductive losses.

Regardless of the alternative, life-of-mine facilities and well field preparation would involve the clearing, occupation, and alteration of habitats suitable for raptor nesting and foraging activities (see Table 4-7 for acreage summary among alternatives).

Clearing of pinyon-juniper woodlands would result in long-term (100 to 150 years) conversion of mature forested habitats to a successional shrub-grass association, thereby precluding nesting and some foraging activities of forest dwelling raptors.

Native shrub-grass habitats cleared for development would be temporarily unavailable for raptor foraging use before rehabilitation. Shrubland losses associated with well field development would be of shorter duration (4 to 5 years) than that involving life-of-mine facility occupation (30 to 35 years).

The degree of long-term impacts on raptor habitat would depend largely on well pair spacing and raptor species considered. The more distant individual wells of a well pair are spaced, the less forested habitat would require clearing, thereby reducing potential impacts to forest dwelling raptors (e.g., Cooper's hawk, long-eared owl). For example, at 300-foot spacing, about 70 percent of the well field would require clearing; at 600 feet, only about 40 percent would be cleared. Conversely, necessary woodland clearing and subsequent reclamation might enhance the interspersion of nonforested habitats within remaining woodlands and favor those raptors adapted to foraging in open situations (e.g., rough-legged hawk, golden eagle). Thus, woodland clearing might enhance or degrade raptor nesting and foraging habitat by altering the relative distribution and interspersion of forested versus nonforested (reclaimed) habitats.

Raptor use of the project area would adjust commensurate with available habitat. Potential for woodland raptor use would be subject to long-term decline until redevelopment of a mature pinyon-juniper woodland type. In the interim, the potential for soaring hawk and eagle use of the project area would increase.

TABLE 4-7

SUMMARY OF RAPTOR HABITAT LOSS AND/OR MODIFICATION

	Affected Acreage by Alternative			
Impact	**No Action**	**50,000**	**125,000**	**500,000**
Woodland Conversion Over Mine Life [a]				
Facilities	4.3	4.2	4.2	38
Well Field	0.2	23-57 [b]	49-123	148-369
Total	4.5	28-61	54-127	186-406
Foraging Habitat Loss [c]				
Facilities	17	74	89	149
Well Field (Maximum)	4	11	28	112
Total (Maximum)	21	85	117	261
Average Annual Rate of Well Field Expansion	2	1-3	2-7	12-15

[a] Long-term loss of potential nest substrate and woodland foraging habitat of forest-dwelling raptors.

[b] Ranges are minimum and maximum. Actual loss is dependent on well field configuration relative to existing woodland vegetation and well pair spacing.

[c] Total potential habitat unavailable (not rehabilitated) at any given time over mine life; particularly with regard to raptors preferring to hunt nonforested vegetation types.

With the incorporation of mitigative stipulations, it is unlikely that breeding or wintering raptor populations in the Piceance Basin would be measurably affected by any of the proposed nahcolite mining alternatives.

4.9.3 Upland Game Birds and Waterfowl

None of the proposed plant facility or well field sites would infringe on occupied sage grouse range, although improved road access (commercial alternatives) would traverse spring and winter use areas on Bar D Mesa. Habitat losses associated with road improvement are considered negligible; however, increased vehicular traffic and human contact with grouse could result in locally important mortality as a result of poaching and road kills.

Temporary losses imposed on dove nesting habitat, regardless of alternative, would be inconsequential to the resident dove population in Piceance Basin.

No significant alteration or reduction of waterfowl habitats in Piceance or Yellow creeks would occur as a result of the No Action and 50,000 TPY alternatives, and under normal conditions, as a result of the 125,000 TPY Alternative. During dry years (averaging 1 year in 4), groundwater use in th 125,000 TPY Alternative might reduce average summer flows in lower Yellow Creek by 20 to 40 percent. This would cause temporary and minor reductions in the extent and quality of brood rearing habitats available for late nesting waterfowl (e.g., cinnamon teal).

Implementation of the 500,000 TPY Alternative would largely degrade and occasionally eliminate the small amount of waterfowl habitat existing in lower Yellow Creek only. Flow reduction during the nesting season (April-June) would average 20 to 40 percent, increasing up to 60 percent by August. During dry years, flow reductions could approach 80 percent by June, with flow being essentially absent from July through September. These conditions would probably preclude waterfowl nesting and displace fall migratory use.

These regionally minor impacts to waterfowl would persist through mine life, and to some degree until aquifer recharge (up to 50 years beyond end of mine life).

4.9.4 Furbearers and Nongame

Loss and modification of habitats resulting from any development option would cause no discernible reduction in populations of nongame or furbearing animals inhabiting Piceance Basin.

Long-term modification of mature pinyon-juniper woodlands (up to 406 acres in the 500,000 TPY Alternative) would reduce local animal populations associated with this habitat type for up to 150 years, but such losses would be considered insignificant in the context of remaining habitat available in Piceance Basin (172,000 acres). Disturbed acreages would become reoccupied by nongame and furbearing animals as quickly as reclaimed areas assumed characteristics that would satisfy individual species' needs.

4.9.5 Threatened and Endangered Species

Regardless of alternative, nahcolite mining and processing would require that water be obtained and consumed from groundwater sources (Table 4-3). The groundwater depletions (as shown in Table 4-3) although insignificant from this specific project, would ultimately reduce surface water volumes in the White River and downstream endangered species' fisheries due to the cumulative effects of all the projects in this area.

Maintenance of high-river flows is thought to be a vital component in the protection of aquatic habitats supporting endemic fishes in the lower White, Green, and Colorado rivers. Historical flows have developed and maintained the quiet backwaters used as nursery areas by squawfish, humpback chub, and razorback suckers, and as preferred habitat for adult razorback suckers (Parkhurst 1984). Even small depletions would contribute to flow reductions that would further diminish or eliminate these backwater habitats, the loss of which could jeopardize successful reproduction and the continued survival of these species. Water development projects have already been implicated in reduced average monthly peak flows of 25 to 40 percent in the Green River and 35 percent in the Colorado River (Miller et al. 1982).

Groundwater consumed through mine life would contribute cumulatively to adverse alterations of downstream endangered fish habitat, although individual increments would probably not jeopardize the continued existence of any listed fish. This analysis by BLM is strictly preliminary. Final impact analyses, determination of significance, and conservation recommendations will be finalized upon completion of Section 7 Consultation now being conducted with the USFWS.

BLM believes that development of any of the mine alternatives would not adversely influence wintering bald eagle populations or associated foraging habitat. Occupation of up to 345 acres at any given time over mine life (500,000 TPY Alternative) would not measurably diminish the extent of similar low elevation foraging habitat available to eagles in Piceance Basin (157,029 acres). Long-term conversion of mature woodland types to open shrublands would increase the extent of foraging habitats available to eagles.

For additional information regarding candidate or listed threatened and endangered species, see BLM's Biological Assessment for the project area (Appendix D).

4.9.6 Aquatic, Wetland, and Riparian Habitats

Regardless of alternative, aquatic and wetland vegetation supported by Piceance Creek would not be measurably influenced by the small degree of base flow reductions effected by groundwater pumping.

The small amount of aquatic and wetland vegetation supported by lower Yellow Creek (less than 1 acre) would remain essentially unaffected by base flow reductions associated with the No Action and 50,000 TPY alternatives. Under the 125,000 TPY Alternative, no appreciable change in the extent or distribution of aquatic/wetland vegetation would be expected during years of normal snowpack and precipitation. During dry years, spring and early summer flows would remain relatively unchanged, but 20 to 40 percent reductions could be expected from July through September. These conditions would probably lead to minor constrictions (up to 10 percent) of wetland and riparian fringe areas.

Groundwater use associated with the 500,000 TPY Alternative would probably induce notable flow reductions in lower Yellow Creek. Early summer flow reductions could average 20 to 40 percent through June, increasing to 60 percent by August. During dry years, 70 to 80 percent reductions could be expected by June, with flow essentially absent from July through September. Flow reductions and periodic drying of the channel would drastically reduce consistent support of aquatic and wetland communities in affected portions of Yellow Creek. Wetland extent and quality would gradually deteriorate over mine life, reaching maximum loss at end of mine life and persisting for at least 20 years beyond end of mine life. Wetland and aquatic resource losses in Yellow Creek, although long term, would be very small in areal extent and would be considered completely reversible.

4.10 Cultural Resources

Impacts to cultural resources from development of the project area would be the same for all alternatives. The direct impact would be inadvertent destruction of known or unknown cultural resources as a result of earth disturbing activities associated with construction of the handling and processing plant and ancillary facilities such as well fields, roads, powerlines, pipelines, topsoil stockpiles, etc.

The most prevalent indirect impact in and adjacent to the project area would be the increased destruction of cultural resources through unauthorized collection and/or excavation (Williams 1977, Decker and Vlcek 1978, Nickens et al. 1981). This might occur because of two primary factors: 1) the increased work force in the area, and 2) the upgrading or construction of roads making the area more accessible to vehicular travel and illegal cultural resource collection/destruction.

Another indirect impact could result from changes in livestock grazing patterns and movements. These changes could result in livestock inadvertently disturbing or destroying cultural resources. Based on the low level of grazing in this area, the likelihood of this occurring would be minimal.

The direct and indirect impacts from development of the project area could result in the loss of potentially important information to the regional data base, which might not be recoverable utilizing present archaeological techniques. According to established federal guidelines, a cultural resource must be evaluated for its significance to the National Register of Historic Places (NRHP) before a determination can be made on the proposal's effect on that cultural resource (36 CFR 800). Although known sites would be directly impacted by sodium development, whether or not the cultural resources would be adversely affected could only be determined subsequent to a formal evaluation to the National Register of Historic Places.

Although the potential impacts on cultural resources would be the same under each alternative, the number of cultural sites affected would change. Table 4-8 lists the known cultural sites that would potentially be impacted, type of site, determination of eligibility to the NRHP, and management recommendations. The table is cumulative and shows only additional sites impacted under each successive alternative.

Portions of the 500,000 tpy well field have not been inventoried to date. A 100 percent pedestrian inventory would be required before work would begin in those areas.

See Table 4-9 for an estimation of cultural sites that would be impacted as a result of cumulative development within the Piceance Basin. Using a predicted site density of 16.6 cultural resource sites per section (USDI, BLM Draft C-a Offtract EIS 1985b), it can be estimated that for each additional 640 acres of surface disturbed by development in the Piceance Basin, an additional 16.6 sites would be lost from the archaeological record.

TABLE 4-8

SITES AFFECTED UNDER ALTERNATIVES

Site No.	Site Type	NRHP Eligible	Management Recommendation
No Action Alternative [1]			
5RB390	Open Campsite/ Historic	No	Avoid
5RB392	Open Lithic	No	No further work
5RB394	Open Campsite	No	No further work
5RB400	Open Campsite	Potentially eligible	Avoid/Mitigate
50,000 TPY Alternative			
5RB1907	Isolated Find	No	No further work
5RB2500	Open Campsite	Potentially eligible	Mitigate
5RB2734	Isolated Find	No	No further work
Proposed Action (125,000 TPY) Alternative			
5RB1901	Isolated Find	Not eligible	No further work
5RB1903	Isolated Find	Not eligible	No further work
5RB2616	Isolated Find	Not eligible	No further work
500,000 TPY Alternative			
5RB396	Open Lithic	Need data	Reevaluate/Nominate/Avoid
5RB398	Open Camp	Potentially eligible	Nominate/Mitigate
5RB1876	Wickiup	Potentially eligible	Nominate/Mitigate
5RB1877	Open Camp (?)	Not eligible	No further work
5RB1900	Isolated Find	Not eligible	No further work
5RB1906	Isolated Find	Not eligible	No further work
5RB2614	Isolated Find	Not eligible	No further work
5RB2615	Isolated Find	Not eligible	No further work
5RB2617	Isolated Find	Not eligible	No further work
5RB2618	Isolated Find	Not eligible	No further work
5RB2619	Isolated Find	Not eligible	No further work

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[1] See Pilot Plant EA, BLM, Craig District.

Indirect impacts to paleontologic resources might include the destruction of paleontological resources through unauthorized collection of vertebrate fossils or significant invertebrate fossils. Excessive (over 25 pounds per person) collection of petrified wood might also occur. Indirect impacts might occur because of: 1) the increased work force in the area, and 2) the upgrading or construction of roads making the area more accessible to vehicular travel and illegal fossil collection.

4.11 Paleontological Resources

Impacts to paleontological resources from development of the project area would be the same for all alternatives. The direct impact would be the inadvertent destruction of known or unknown paleontological resources as a result of earth disturbing activities associated with construction of the handling and processing plant and ancillary facilities such as well fields, roads, powerlines, pipelines, topsoil stockpiles, etc.

The direct and indirect impacts of the alternatives could result in the loss of potentially important information to the paleontologic data base. According to established guidelines, a paleontologic resource must be classified and evaluated for its scientific significance before a determination can be made of the effect of the proposal to that paleontologic resource. Paleontologic resources could be directly impacted by the Proposed Action and alternatives. Adverse effects can only be determined by evaluations of the scientific significance of the resource. The advice and expertise of the Geological Advisory Group (State of Colorado Natural Areas Program) should be sought in making evaluations of significance and in developing special management areas for paleontological resources.

The area of the described alternatives is in the Uinta Formation, which has been classified as a Ib Formation. Mitigative measures would be implemented to comply with existing legislation and guidelines in regard to the Class Ib Formation in order to mitigate the primary, direct impacts.

Although the potential impacts on paleontological resources would be the same under each alternative, the number of sites impacted would change. Table 4-10 lists the known paleontological sites that would potentially be impacted by each alternative.

Cumulative impacts could result in from four to seven known paleontological resource sites being affected, depending upon the alternative. Table 4-11 summarizes cumulative impacts for the Piceance Basin.

4.12 Lands and Realty

Development under the Proposed Action or other alternatives would influence, but would not preclude, either existing oil and gas lease development rights or future oil shale leasing.

Sodium development would potentially complicate future oil and gas development and future oil shale leasing in terms of locating well pads, pipelines, and other surface facilities associated with such leasing rights. When considering a 30-year commercial-scale project, this could adversely influence the development of other existing and future mineral leases through diminished surface occupancy possibilities.

Beneficial influences associated with sodium development might include reduced costs to future developers, as reflected in shorter distances to utilities and improved roads.

Access road upgrades and construction of the buried natural gas and water pipelines would create undesignated utility corridors. These corridors might invite location of future transportation and utility facilities (electric powerlines, telephone cables, other pipelines, etc.).

If a commercial-scale sodium solution mine were approved and subsequently developed, future uses of these lands might shift from predominantly wildlife use and livestock management to mineral development and light industrial.

USGS's recognized right to monitor certain water wells within the sodium lease tracts would not be interfered with.

4.13 Recreation/Visual Resources

4.13.1 Recreation

All alternatives would restrict access to the proposed project area. This would eliminate recreational activity off of existing roads and trails on the areas identified for the handling and processing plant and associated ancillary facilities. Each alternative would result in the disturbed acreage being shifted from the semiprimitive motorized recreation opportunity spectrum (ROS) to the rural ROS, as identified in Chapter 3.

Current recreational use in the area (primarily big game hunting, camping, and firewood cutting) would shift to other areas of the Piceance Basin. Direct effects on recreational opportunities caused by construction and operations include: land disturbance, noise, game habitat loss, increased traffic on previously little traveled roads, construction of new roads, displacement of both game animals and hunters, and an aesthetic depreciation of the immediate area.

Although hunter use cannot be quantified for the specific site, roads on the site are used extensively by hunters during the appropriate seasons. If any of the roads were closed because of mining activity, access would be denied to hunters. Displacement of game from the immediate area would be another reason for a decline in hunting opportunities.

Although the effect on recreation is the same for all alternatives, the degree of impact would change, depending on the number of acres involved under each alternative. The affected area that would change to a rural ROS ranges from 43 to 960 acres, depending on the alternative; regardless, the overall impact on recreation would be insignificant.

In addition to impacts to specific acreages within the alternatives, adjacent areas would also be affected. Because of increased personnel, increased traffic and noise,

TABLE 4-9

CULTURAL RESOURCE MANAGEMENT SITES IMPACTED BY CUMULATIVE DEVELOPMENT IN THE PICEANCE BASIN

	No Action/ Pilot Plant	50,000 TPY Alternative	Proposed Action 125,000 TPY Alternative	500,000 TPY Alternative
WRC	4	7	10	21
C-b	13	13	13	13
C-a	78	78	78	78
C-a Offtract 84 Mesa [1]	177	177	177	177
Total	272	275	278	289

[1] Known and Predicted.

TABLE 4-10

AFFECTED PALEONTOLOGICAL SITES

Alternative	No. Paleontological Sites
No Action	0
Proposed Action	3
50,000 TPY	0
500,000 TPY	3 [a]

[a] The three sites impacted under this alternative are the same as under the Proposed Action.

TABLE 4-11

KNOWN PALEONTOLOGIC LOCALITIES IN PICEANCE BASIN

	No Action/ Pilot Plant	50,000 TPY Alternative	Proposed Action 125,000 TPY Alternative	500,000 TPY Alternative
WRC	0	0	3	3
C-b [a]	2	2	2	2
C-a [a]	2	2	2	2
C-a Offtract 84 Mesa [a]	0	0	0	0
Total	4	4	7	7

[a] Known and Predicted.

development of ancillary facilities, and visual impacts that could be seen from a distance, an undetermined amount of additional acreage would be impacted by development in the project area. When added to similar projects within the Piceance Basin, the cumulative effect would be an overall reduction in lands suitable for inclusion in potential future Special Recreation Management Areas (SRMAs).

4.13.2 Visual Resources

The impact to visual resources would be the same for all alternatives. The project area would be stripped of vegetation and topsoil for placement of the handling and processing plant, active well pairs, and ancillary facilities that would be in place for the duration of the mine. The landform would remain unchanged, except for localized cuts and fills. During the life of the project, facilities, structures, roads, topsoil stockpiles, and powerlines would dominate the area. The project would be in sharp contrast to the surrounding natural environment and would result in the subject land and immediate viewshed around the site being degraded to a Visual Resource Management Area Class V level, a class reserved for areas requiring rehabilitation or enhancement. The development of the area under any of the alternatives would result in the visual domination of the landscape. However, with proper mitigation (painting of structure with a noncontrasting color) and restoration of the landscape upon project completion, the visual domination and impact would be localized and would not significantly alter the visual resources of the overall area.

Other projects in the Piceance Basin would add to the overall effect of reduced visual qualities throughout the area. Mitigation has the potential to restore areas to prior existing levels, but overlap between projects and reclamation would leave a constant state of disturbance.

4.14 Transportation

Projected traffic increase, including both haul vehicles and employee traffic, would only result in road utilization of 51 percent of capacity at the highest production alternative (i.e., 500,000 TPY); therefore, no adverse impacts would occur.

Mitigative measures proposed by the applicant should effectively resolve most impacts on the transportation system at any level of production. However, cumulative impacts from other construction and production facilities in the same general area might require modernization of RBC Road 24 and 5 and State Highway 13. This modernization would include road widening, curve realignment, and resurfacing of roadways to accommodate heavier traffic volumes.

4.15 Noise

Noise levels at the proposed site would be increased because of mining activity and would range from 93.1 dB to 94.5 dB (Gardiner 1985). Because of spherical and standard divergence attenuation, vegetation and "soft site" characteristics of the project area, the sound levels would be reduced and would range from 32.3 dB to 37.0 dB (Gardiner 1985). This increase from present levels caused by mine development equipment, on-site generators and increased traffic would not be significant.

4.16 Socioeconomics

4.16.1 Social

Annual population growth rate is the best single indicator of degree of social impacts. Annual growth or decline of less than 1 percent generally produces no measurable social impacts; from 1 to 4 percent annual growth would produce low impacts; from 4 and 8 percent, moderate impacts; from 8 to 13 percent, high impacts; and more than 13 percent, severe social impacts.

In general, attitudes toward growth are positive in northwestern Colorado. In Rifle and Meeker there are surplus facilities, though more so in Rifle than in Meeker. Thus, some of the usual negative social impacts from overcrowding and shortage would not occur under moderate growth.

Table 4-12 presents population changes by alternative from the No Action. All the changes from 1995 to 2009 represent less than a 1 percent annual growth in population for either county. Thus, there should be no significant social impacts under any of the alternatives. The cumulative population impacts are also presented in Table 4-12 by alternative.

The average annual population change is less than 1 percent when comparing each alternative to the 1985 baseline. Thus, no significant impacts would occur from the Proposed Action and the other projects projected in the baseline.

Some of the affected communities, however, could experience some small short-term population fluctuations, depending on the actual schedule of the proposed projects in the baseline. Because of the general readiness of the region to absorb new growth, any fluctuations in growth could probably be accommodated without drastic social stresses.

TABLE 4-12

POPULATION

Alternative by County	Population (Persons)	Change From No Action	Percent Change From No Action	Cumulative Impact Change From 1985 (Baseline)	Cumulative Average Annual Change From 1985 Baseline
YEAR 1995					
Garfield County					
No Action	30,933			1,838	<1
Proposed Action	31,025	92	0.3	1,930	<1
50,000 TPY Alternative	31,014	81	0.3	1,919	<1
500,000 TPY Alternative	31,120	187	0.6	2,025	<1
Rio Blanco County					
No Action	7,138			400	<1
Proposed Action	7,191	54	0.8	454	<1
50,000 TPY Alternative	7,178	41	0.6	441	<1
500,000 TPY Alternative	7,245	108	1.5	508	<1
YEAR 2009					
Garfield County					
No Action	34,335			5,240	<1
Proposed Action	34,429	94	0.3	5,334	<1
50,000 TPY Alternative	34,409	74	0.2	5,314	<1
500,000 TPY Alternative	34,508	173	0.5	5,413	<1
Rio Blanco County					
No Action	7,285			548	<1
Proposed Action	7,336	51	0.7	599	<1
50,000 TPY Alternative	7,325	40	0.6	588	<1
500,000 TPY Alternative	7,383	98	1.4	648	<1

Source: Colorado Division of Local Government, Planning and Assessment System 7/85.

4.16.2 Economics

4.16.2.1 Introduction and Summary

For the purpose of this analysis, baseline projections were calculated for Garfield and Rio Blanco counties, using activities selected from the Basic Activity System of the Cumulative Impact Task Force (CITF). A list of activities assumed as baseline are described in Chapter 2.

Development of any of the three alternative levels would not cause significant economic consequences in the region for either Garfield or Rio Blanco County. Even when the project is combined with other baseline projects, the combination does not create significant economic impacts. Significant economic impacts are defined as having an average annual change of more than 2 percent per year in employment, income, and housing.

The baseline projections for 1985 assume current market conditions. If any of the projects in the baseline were terminated or if any others were proposed in the future, the cumulative impacts would be of a different level than currently projected. The actual timing and construction of baseline projects could have a significant effect on a community in a particular year.

4.16.2.2 Proposed Action

A temporary peak construction work force of 128 individuals would be required. A permanent work force of 45 individuals would be required to operate the plant. Product transport, which would probably be based out of Rifle, would require approximately 12 employees.

Tables 4-12 through 4-15 present the total employment, income, population, and housing demand for 1995 and 2009 for the Proposed Action. The impacts of the Proposed Action and the cumulative impacts from the 1985 baseline are not

TABLE 4-13

COUNTY EMPLOYMENT (PERSONS)

Alternative by County	Total Employment	Change From No Action	Percent Change From No Action	Cumulative Impact Change From 1985 Baseline	Cumulative Average Annual Change From 1985 Baseline
YEAR 1995					
Garfield County					
No Action	19,029			1,603	<1
Proposed Action	19,075	46	0.2	1,649	<1
50,000 TPY Alternative	19,066	37	0.2	1,640	<1
500,000 TPY Alternative	19,116	87	0.5	1,690	<1
Rio Blanco County					
No Action	3,854			271	<1
Proposed Action	3,879	25	0.7	296	<1
50,000 TPY Alternative	3,874	20	0.5	291	<1
500,000 TPY Alternative	3,902	48	1.2	319	<1
YEAR 2009					
Garfield County					
No Action	20,565			3,139	<1
Proposed Action	20,612	47	0.2	3,186	<1
50,000 TPY Alternative	20,603	38	0.2	3,177	<1
500,000 TPY Alternative	20,653	88	0.4	3,227	<1
Rio Blanco County					
No Action	4,000			417	<1
Proposed Action	4,026	26	0.7	443	<1
50,000 TPY Alternative	4,021	21	0.5	438	<1
500,000 TPY Alternative	4,048	48	1.2	465	<1

Source: Colorado Division of Local Government, Planning and Assessment System 7/85.

TABLE 4-14

COUNTY LABOR INCOME (IN THOUSANDS 1984 DOLLARS)

Alternative by County	Total Labor Income	Change From No Action	Percent Change From No Action	Cumulative Impact Change From 1985 Baseline	Cumulative Average Annual Change From 1985 Baseline
YEAR 1995					
Garfield County					
No Action	$340,658			$28,431	<1
Proposed Action	341,815	$1,157	0.3	29,588	<1
50,000 TPY Alternative	341,582	924	0.3	29,355	<1
500,000 TPY Alternative	342,837	2,179	0.6	30,610	<1
Rio Blanco County					
No Action	$80,169			$6,806	<1
Proposed Action	80,850	$681	0.8	7,487	<1
50,000 TPY Alternative	80,714	545	0.7	7,351	<1
500,000 TPY Alternative	81,455	1,286	1.6	8,092	1.1
YEAR 2009					
Garfield County					
No Action	$8,366,592			$54,365	<1
Proposed Action	367,766	$1,174	0.3	55,539	<1
50,000 TPY Alternative	367,530	938	0.3	55,303	<1
500,000 TPY Alternative	368,803	2,211	0.6	56,576	<1
Rio Blanco County					
No Action	$83,296			$9,933	<1
Proposed Action	83,982	$686	0.8	10,619	<1
50,000 TPY Alternative	83,845	549	0.7	10,482	<1
500,000 TPY Alternative	84,592	1,296	1.6	11,229	<1

Source: Colorado Division of Local Government, Planning and Assessment System 7/85.

TABLE 4-15

HOUSING UNITS

Alternative by County	Housing Demand	Change From No Action	Percent Change From No Action	Cumulative Impact Change From 1985 Baseline	Cumulative Average Annual Change From 1985 Baseline
YEAR 1995					
Garfield County					
No Action	2,165			135	<1
Proposed Action	2,172	7	0.3	142	<1
50,000 TPY Alternative	2,172	7	0.3	142	<1
500,000 TPY Alternative	2,182	17	0.8	152	<1
Rio Blanco County					
No Action	1,144			67	<1
Proposed Action	1,150	6	0.5	73	<1
50,000 TPY Alternative	1,148	4	0.4	71	<1
500,000 TPY Alternative	1,155	11	1.0	78	<1
YEAR 2009					
Garfield County					
No Action	2,493			463	<1
Proposed Action	2,500	7	0.3	470	<1
50,000 TPY Alternative	2,499	6	0.2	469	<1
500,000 TPY Alternative	2,510	17	0.7	480	<1
Rio Blanco County					
No Action	1,202			125	<1
Proposed Action	1,207	5	0.4	130	<1
50,000 TPY Alternative	1,206	4	0.3	129	<1
500,000 TPY Alternative	1,212	10	0.8	135	<1

Source: Colorado Division of Local Government, Planning and Assessment System 7/85.

significant. The percentage change from the No Action would be less than 1 percent for employment, income, population, and housing for each county. The average annual percentage cumulation change from the 1985 baseline would be less than 1 percent.

Impacts to Other Resources

On a county-wide basis, all effects of this alternative on agriculture and recreation would be insignificant.

Local Government Finances

Development of the Proposed Action would add to government revenue at all levels. All school districts have sufficient bonding capacity to meet low to moderate growth levels.

4.16.2.3 50,000 TPY Alternative

A temporary peak construction work force of 84 individuals would be required. A permanent work force of 36 individuals would be required to operate the plant. Product transport, which would probably be based out of Rifle, would require approximately six employees.

Tables 4-12 through 4-15 present the total employment, income, population, and housing demand for 1995 and 2009 for this alternative. The percentage change from the No Action for this alternative would be less than 1 percent for employment, income, population, and housing demand for each county. The average annual percentage cumulative change from the 1985 baseline would be less than 1 percent for each county. Thus, the impacts of this alternative would not be significant.

Impacts to Other Resources

Same as the Proposed Action.

Local Government Finances

Same as the Proposed Action.

4.16.2.4 500,000 TPY Alternative

A temporary peak construction work force of 200 individuals would be required. A permanent work force of 85 individuals would be required to operate the plant. Product transport, which would probably be based out of Rifle, would require approximately 30 employees.

Tables 4-12 through 4-15 present the total employment, income, population, and housing demand for 1995 and 2009 for this alternative. The percentage change for this alternative from the No Action would be less than 1 percent for employment, income, population, and housing for Garfield County. The percentage change for Rio Blanco County would be a little higher, but in no case would it go above 2 percent. The average annual percentage cumulative change from the 1985 baseline in all cases but one would be less than 1 percent. Labor income increases for Rio Blanco County average 1.1 percent to the year 1995. Thus, the impacts to this alternative and the cumulative impacts from the 1985 baseline would not be significant.

Impacts to Other Resources

Same as the Proposed Action.

Local Government Finances

Same as the Proposed Action.

4.16.2.5 No Action Alternative

A temporary work force of approximately 40 individuals would be required for the estimated 4-month construction of the pilot plant. An operational work force of 13 individuals would be required for the 2-year operation of the pilot project. These people would work and live in either Rifle or Meeker. Thus, no significant economic effects would be felt by local/regional communities because of the small scale and limited duration of the pilot plant project. The average annual percentage cumulative change from the 1985 baseline would be less than 1 percent for employment, income, population, and housing demand for both counties and would not be significant.

Impacts to Other Resources

Same as the Proposed Action.

Local Government Finances

Same as the Proposed Action.

4.17 Energy Requirements

Table 4-16 is a computation of the energy requirements of the Proposed Action and alternatives (i.e., the amount of energy required to produce nahcolite). Energy requirements are by pertinent component and are expressed in British thermal units (Btus). This analysis follows guidelines contained in Colorado State BLM Instruction Memo No. CO-81-302.

4.18 Summary of Impacts

Table 2-2 at the end of Chapter 2 summarizes the impacts identified in this chapter in a comparative format for the four alternatives analyzed in detail. In addition to this comparative table, a summary of impacts by affected resource is described below. Uncommitted mitigative measures, which address these impacts, are listed in Section 4.18.5 in Chapter 4.

TABLE 4-16

ENERGY REQUIREMENTS (Btus x 10^{10})

	Alternatives			
Component	**No Action**	**50,000 TPY**	**Proposed Action (125,000 TPY)**	**500,000 TPY**
Mine Operation	18.70	16.30	41.60	111.43
Product Transportation	.41	.57	1.43	5.70
Coal Transportation	—	—	—	.60
Employee Transportation	.39	.54	.67	1.40
Infrastructure Support	.08	.11	.14	.27
Total Year	19.58	17.52	43.84	119.40
Total Life	39.16	525.60	1,315.00	3,582.00

4.18.1 Adverse Environmental Effects Which Cannot be Avoided

4.18.1.1 Air Quality

A small amount of degradation of local air quality would occur through the addition of pollutants (primarily particulates, carbon monoxide, SO_2 and NO_2) to the atmosphere. This degradation would last from 2 to 30 years, depending on the alternative.

Under the 500,000 TPY Alternative, there could be a significant degradation of air quality because of particulate emissions for the 30-year project life.

4.18.1.2 Rock Quality

Rock quality of strata immediately overlying the cavities would be significantly reduced if the cavity roof collapsed or pillar failure occurred; however, impact on the rock quality of the Mahogany Zone should not be significant.

4.18.1.3 Solid Minerals

Sodium minerals within the L-5E Zone, lying above the well field, and those remaining within the Boies Bed (pillars between cavities) potentially would no longer be available for future recovery.

4.18.1.4 Water Resources

There would be the potential for an unavoidable impact to the quality of the water in the lower aquifer because of the amount of increase in the surface area of the base of the lower aquifer in contact with salt. This potential impact would persist for the foreseeable future and would be the result of cavity collapse.

4.18.1.5 Soils

An undetermined amount of soil and plant nutrients would be displaced from the disturbed area because of water and wind erosion.

Impacts to the soil resource would occur in the form of complete alteration of the natural soil horizons that has developed over thousands of years. The disruption of the soil profile and the introduction of new parent materials would result in a decrease of diversity of soil communities. The texture of the topsoil would be altered by mixing within itself and by the introduction of quantities of fine textured subsoil material with very low nutrient levels. In addition, the permeability and infiltration rates might be decreased because of compaction. This, in turn, would modify the soil microclimate, nutrients and energy cycles affecting the soil fertility and productivity.

Prime or Unique Farmlands and Statewide Important Farmlands

Loss of productivity along Yellow Creek on irrigated farmlands of statewide importance from water contamination would result in an unavoidable impact to agricultural production.

4.18.1.6 Vegetation

Composition and production of species in subclimax communities on revegetated areas would be expected to differ from that of the plant communities present before disturbance. This would be expected even if the species planted were similar to the predisturbance community, because of differences in site conditions on the disturbed areas.

Remnant Vegetation Associations (RVAs)

The disturbance of the RVA would eliminate the future possibility of this plant community's designation for special management.

4.18.1.7 Livestock Grazing

Forage production would be unavoidably lost on disturbed areas because of development.

4.18.1.8 Wildlife

Regardless of alternative, mining would temporarily reduce the available extent of wildlife habitats in the project area. Affected species would be prevented from occupying or would refrain from using portions of the project area over mine life.

The reclamation of former forested habitats to a brush/grass type would result in long-term habitat modifications. Reclaimed areas would support wildlife populations with characteristics commensurate with the extent, distribution and condition of altered habitats.

Mitigation could not be expected to be totally effective at preventing animal loss as a result of poaching and road kills, nor at protecting all nesting attempts of woodland raptors.

4.18.1.9 Cultural Resources

If inadvertent disturbance of cultural sites occurred as a result of construction, vandalism, or change in livestock grazing patterns in the project area, destruction or loss of cultural resources could occur under all alternatives.

4.18.1.10 Paleontological Resources

If inadvertent disturbance of paleontological sites occurred from construction or vandalism in the project area, destruction or loss of paleontological resources could occur under all alternatives.

4.18.1.11 Lands and Realty

The improved access road, natural gas and water pipelines would create undesignated utility corridors that would encourage future utility right-of-way proposals.

Commercial-scale sodium development might adversely influence the development of other existing and future mineral leases through diminished surface occupancy possibilities.

4.18.1.12 Recreation

The acreage impacted by each alternative would change from the semiprimitive motorized to the rural recreation opportunity spectrum.

4.18.1.13 Visual Resources

Visual qualities of the areas affected by project development would be downgraded to a Class V VRM class. This would have an adverse impact on recreational users in the area who value a natural and primitive environment.

4.18.2 The Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

4.18.2.1 Solid Minerals

Upon completion of the project in the area overlying the well field, the sodium minerals extracted and those remaining in the Boies Bed potentially would no longer be recoverable with current technologies and economics.

4.18.2.2 Water Resources

There would be the potential for a short-term reduction in the flow of Yellow Creek as a result of the production of water for use by the mine. This reduction in flow would not exist for more than 50 years after the end of mine life. There would be the potential for a long-term impact to the quality of the water in the lower aquifer because of the amount of increase in the surface area of the base of the lower aquifer in contact with salt as a result of cavity collapse. This potential impact would persist for the foreseeable future.

4.18.2.3 Soils

Alteration of existing soil profiles by handling, intermixing, and stockpiling disrupts the nutrients and energy cycling of the topsoil, and results in lower soil fertility levels and subsequent reductions in potential productivity in the short-term. With successful reclamation, the nutrient and energy cycling in the topsoil would return to predisturbed levels within 20 to 50 years.

4.18.2.4 Vegetation

During the short term, vegetation on from 43 to 960 acres of land, depending on the alternative, would be lost to surface disturbance. In the long term, vegetation would be replaced with forage production being equal to, or potentially better than, that before disturbance.

4.18.2.5 Livestock Grazing

There would be a short-term loss of forage, which, after successful revegetation, would result in improved and increased forage production in the long term above that of the existing plant communities. This increased forage production, if realized, would result in a proportionate increase in livestock grazing potential.

4.18.2.6 Wildlife

Wildlife-oriented reclamation would adequately compensate for long-term mule deer winter range loss, potentially improving predevelopment forage availability and quality. Raptors and other woodland adapted species would experience insignificant long-term loss of forested habitats.

4.18.2.7 Cultural Resources

Inadvertent destruction of cultural resources that could result from surface disturbing activities would result in a permanent loss of data.

4.18.2.8 Paleontological Resources

Inadvertent destruction of paleontological resources from surface disturbing activities would be a permanent loss of scientific and educational material from the paleontological data base.

4.18.2.9 Lands and Realty

The ancillary facility rights-of-way would establish undesignated utility corridors. Future transportation and transmission facilities might be considered for authorization within these corridors.

Beneficial influences resulting from commercial-scale development would include reduced costs to future developers, which would be reflected in closer distances to upgraded roads and utilities.

4.18.2.10 Recreation

During the life of the project, recreational activities in and around the area would shift to other portions of the Piceance Basin.

4.18.2.11 Visual Resources

During the short term, visual qualities would be forgone in order to develop the mineral resource. In the long term, restoration of disturbed areas would again resemble a natural environment with scenic interest.

4.18.3 Irreversible or Irretrievable Commitment of Resources

4.18.3.1 Rock Quality

See section 4.18.1.2.

4.18.3.2 Water Resources

The water remaining in the cavities after production ceased would be unavailable for all other potential other uses for the foreseeable future. There would be the potential for an irreversible impact to the quality of the water in the lower aquifer because of the amount of increase in the surface area of the base of the lower aquifer in contact with salt as a result of cavity collapse. This potential impact would persist for the foreseeable future.

4.18.3.3 Soils

Loss of an undeterminable amount of topsoil would be inevitable on the disturbed areas because of wind and water erosion. This soil would be irretrievably lost from use in reclamation. The amount of soil lost would be related to the amount of area disturbed, the development method employed, the success of erosion control measures, and the success of the reclamation. Soil pH and texture would be irreversibly changed because of handling of the topsoil.

Prime and Unique Farmlands and Statewide Important Farmlands

Impacts to agricultural land production because of water contamination from nahcolite production would be an irreversible and irretrievable impact.

4.18.3.4 Threatened, Endangered, Candidate, and Sensitive Plant Species

There is no irreversible or irretrievable commitment concerning threatened, endangered, candidate, or sensitive plants. By avoiding the 1 acre of potential habitat, the possibility of supporting a population of Astragalus lutosis in the future would be maintained.

Remnant Vegetation Association (RVA)

Development of the sodium project area could eliminate the RVA from future special management considerations.

4.18.3.5 Cultural Resources

Destruction of the nonrenewable cultural resources, as a result of direct or indirect impacts, would result in an irretrievable and irreversible loss of that resource.

4.18.3.6 Paleontological Resources

Destruction of nonrenewable paleontological resources, as a result of direct or indirect impacts, would result in an irretrievable and irreversible loss of that resource.

4.18.3.7 Lands and Realty

Sodium lease development would produce no irreversible or irretrievable commitment in land-use authorizations or land tenure adjustments. However, such development might modify the utility of the land from its current use.

4.18.4 Cumulative Impacts

4.18.4.1 Air Quality

Long-term degradation of air quality would be possible because of secondary industries and increased urbanization. Also, there might be some long-term impacts to human health, vegetation, and other air quality related values; however, no techniques exist at present to quantify these impacts.

From a cumulative impact standpoint, some degradation of air quality would be irreversible because of established urbanization in the region after the life of the baseline projects.

4.18.4.2 Water Resources

The mine site is approximately 6 miles from the C-a Prototype Oil Shale Tract. The baseline for this environmental impact statement assumes that C-a tract will be in production while this mine is operating. The open-pit mine on Tract C-a would cause very significant impacts to the groundwater system (USDI, BLM 1985b). The dewatering that would be required for mine development could change the rate and direction of flow in the groundwater within the sodium leases. Also, dewatering the pit for C-a could dramatically lower water level and change water quality parameters at the sodium mine site. A detailed plan for the development of Tract C-a is not available. It is therefore not possible to tell with any accuracy what impacts to the groundwater, caused by C-a, would extend to the sodium leases. All that can be said is that these impacts are likely to be very significant. Impacts to the groundwater from the proposed sodium mine are analyzed against existing conditions. The development of Tract C-a, however, could change existing conditions in the groundwater system beneath the sodium leases so dramatically that impacts from the proposed sodium mine would not be seen. The impacts related to the sodium mine are insignificant by comparison with C-a.

4.18.4.3 Vegetation

Development of sodium, depending on the alternative, would potentially disturb between 43 and 960 acres. In addition, up to 50,000 acres could be disturbed regionally because of the development of the oil shale resource. The potential impacts would primarily be within the sagebrush and pinyon-juniper vegetative types. Sagebrush accounts for 42 percent and pinyon-juniper for 28 percent of the plant cover types within the Piceance Basin Planning Unit. On a regional basis, these cover types would not be significantly impacted.

Threatened, Endangered, Candidate, and Sensitive Plant Species

If widespread surface disturbance occurred from the development of oil shale and oil and gas resources elsewhere in the Piceance Basin, some of the presently listed candidate and sensitive plants could become federally listed as threatened and endangered species. In this event, potential habitat would become more important through the introduction of threatened and endangered species onto these sites to increase numbers and populations.

4.18.4.4 Livestock Grazing

The effect of this action, in conjunction with all other projects in the Piceance Basin, would have minimal impacts on the total amount of livestock grazing now taking place in the Piceance Basin.

4.18.4.5 Wildlife

Incremental loss of high-value mule deer winter ranges in Piceance Basin, even if temporary, is considered cumulatively significant. Carrying capacity losses that exceed threshold limits established in the Piceance Basin RMP could significantly reduce populations of deer wintering in the basin and defeat federal and state management objectives designed to sustain herd productivity.

Incremental depletion of flow from the upper Colorado River system is considered detrimental to downstream aquatic habitats of the endangered Colorado River fishes. Cumulative flow depletions are one of the primary reasons these endemic fishes have become endangered.

4.18.4.6 Cultural Resources

See Table 4-9 for an estimation of cultural sites that would be impacted as a result of cumulative development within the Piceance Basin. Using a predicted site density of 16.6 cultural resource sites per section (USDI, BLM 1985b), it can be estimated that for each additional 640 acres of surface disturbed by development in the Piceance Basin, an additional 16.6 sites would be lost from the archaeological record.

4.18.4.7 Paleontological Resources

Cumulative impacts could result in from four to seven known paleontological resource sites being affected, depending on the alternative. Table 4-11 summarizes cumulative impacts for the Piceance Basin.

4.18.4.8 Recreation

When added to similar projects within the Piceance Basin, the cumulative effect would be an overall reduction in lands suitable for potential inclusion in future Special Recreation Management Areas.

4.18.4.9 Visual Resources

Other projects in the Piceance Basin would add to the overall effect of reduced visual qualities throughout the area. Mitigation has the potential to restore areas to prior existing levels, but overlap between projects and reclamation would leave a constant state of disturbance.

4.18.5 Uncommitted Mitigation

4.18.5.1 Air Quality

Cumulative residual air quality impacts may have to be mitigated through application of additional emission controls beyond those called for in the mine plan. The most likely controls would be controls on fugitive dust sources and sources of SO_2 and NO_2.

Because the Class II PSD increment would probably be exceeded from the 500,000 TPY Alternative, the project proponent may want to apply further particulate controls. These can entail more extensive paving of the plant site and roads; more stringent control of emissions from the bulk loading, truck loading and/or boiler operations; or moving the packaging and loading operations off-site.

4.18.5.2 Livestock Grazing

The loss of forage as a result of this action can be regained through rangeland improvements on areas outside the affected area. Additional forage can be developed through various improvement practices such as water development and vegetative manipulations.

4.18.5.3 Cultural Resources

Impacts can be minimized by monitoring areas of proposed surface disturbance, which may be identified as having the potential to contain buried cultural horizons.

4.18.5.4 Paleontological Resources

Impacts can be minimized by monitoring areas of proposed surface disturbance that may be identified as having the potential to contain buried paleontological resources.

5. CONSULTATION AND COORDINATION

5. CONSULTATION AND COORDINATION

Initial consultation efforts began in late 1984 when the Bureau of Mines, at BLM's request, reviewed and commented on the technical adequacy and feasibility of Wolf Ridge Corporation's proposed mine plan. Since then, numerous other agencies, organizations, and individuals have been involved, through consultation and coordination, in the preparation of this environmental impact statement. These include:

State of Colorado

- State Historic Preservation Officer
- Department of Health
  - Air Pollution Control Division
- Department of Natural Resources
  - Mined Land Reclamation Division
  - Division of Wildlife
- Department of Highways

Local Governments

- Rio Blanco County Commissioners
- Town of Meeker
- Garfield County Commissioners
- Town of Rifle

A number of federal organizations were involved as cooperating agencies in this analysis pursuant to 40 CFR, Part 1501.5. These agencies were requested to: 1) provide any information to the BLM that would be pertinent in the environmental analysis, and 2) review the draft EIS from the perspective of specific expertise available in their agency. These agencies are:

- United States Environmental Protection Agency
- United States Department of the Interior
  - Bureau of Mines
  - Fish and Wildlife Service
  - Geological Survey, Water Resources Division

The public was involved through public meetings held in Meeker (June 18, 1985) and Grand Junction (June 19, 1985), Colorado, and through a 30-day written comment period. Very little public interest was expressed. Please see Chapter 1, Section 1.4, for a summary of the scoping process and significant issues. The minutes of the public scoping meetings are available for inspection at the White River Resource Area Office in Meeker, Colorado.

5.1 List of Preparers

5.1.1 Core Team

William F. Frank

Job Title: Environmental Protection Specialist; Project Coordinator/Team Leader

Education: B.S., 1979, Agriculture/Range, California State University, Chico, California

Experience: Biological Technician, Peter Kiewit Sons Co., 5 months; Range Conservationist, BLM, 2 years; Surface Reclamation Specialist, BLM, 3 years; Environmental Protection Specialist, BLM, 1 year

Stanley Foster Beckett

Job Title: Mining Engineer; Technical Coordinator-Physical Resources, Topography, Fluid Minerals, Other Minerals

Education: B.S., 1982, Mining Engineering, Colorado School of Mines, Golden, Colorado

Experience: Mining Engineer, BLM, 2 years

David C. Nylander

Job Title: Multi-Resource Staff Supervisor; Technical Coordinator-Biological/Human Resources, Recreation/ Visual Resources

Education: B.S., 1976, Range Management, Washington State University, Pullman, Washington

Experience: Range Conservationist, BLM, Grand Junction, Colorado, 4 years; Environmental Specialist, BLM, Idaho Falls, Idaho, 2 years; Planner and Environmental Specialist, BLM, Idaho Falls, Idaho, 2 years; Multi-Resource Staff Supervisor, BLM, Meeker, Colorado, 2 years

Beverly Kolkman

Job Title: Technical Publications Editor; Editing

Education: B.A., 1967, History, University of Colorado, Boulder, Colorado; 1976-78 Anthropology, University of Colorado, Boulder, Colorado

Experience: Technical Publications Editor, BLM, 1 year; Writer/Editor, BLM 2 1/2 years; Reports Officer/ Intelligence Analyst, federal government, 7 years

James E. Wilson

Job Title: Environmental Analyst-Data Applications; Data Applications, Graphics

Education: B.A., 1950, Chemistry and Mathematics, University of Denver, Denver, Colorado

Experience: Auto Pollution Coordinator, State of Colorado, 1 1/2 years; Chemist, U.S. Atomic Energy Commission, 4 years; Analytiod Chemist, U.S. Bureau of Mines, 2 years; Chemist, USGS, 1 year; Environmental Scientist, USGS/MMS/BLM, 7 years; Environmental Analyst-Data Applications, BLM, 1 year

Ruth A. Cox

Job Title: Editorial Clerk; Typing

Experience: Clerk-Typist, BLM, 7 years

5.1.2 Contributing Authors

Philip A. Allard

Job Title: Geologist; Hydrology, Technical Coordinator-Physical Resources

Education: B.A., 1975, Geology, Franklin and Marshall College, Lancaster, Pennsylvania

Experience: Research Associate, Duke University, 1 year; Laborer, Forest Service, 1 year; Research Assistant, Forest Service, 1 year; Training Instructor, Forest Service, 4 months; Soil Scientist, BLM, Las Vegas District, 1 1/2 years; Soil Scientist, BLM, Craig District, 3 1/2 years; Geologist, BLM, Craig District, 2 1/2 years

Robert J. Fowler

Job Title: Range Conservationist; Livestock, Vegetation, Special Management Areas, T/E Plants

Education: B.S., 1978, Range and Forest Management, Colorado State University, Fort Collins, Colorado

Experience: Range and Forest Technician, BLM, Deschutes Resource Area, Prineville, Oregon, 6 months; Forest Technician, BLM, Kremmling Resource Area, Kremmling, Colorado, 5 months; Range Conservationist, BLM, White River Resource Area, Meeker, Colorado, 7 years

David Harned

Job Title: Branch Chief, Branch of Technical Support and Assistance; Transportation, Noise, Net Energy

Education: B.S., 1959, General Engineering, University of Wyoming, Laramie, Wyoming

Experience: Civil Engineer, BLM, Rock Springs, Worland, and Rawlins, Wyoming, 12 years; ATROW Specialist, BLM, Craig, Colorado, 4 years; Chief Branch of Technical Support, BLM, Craig, Colorado, 4 years

Randy Heuscher

Job Title: Mining Engineer, Solid Minerals,Geology, Rock Quality/Mechanics

Education: B.S., 1976, Civil Engineering, Montana State University, Bozeman, Montana

Experience: Design Engineer, Construction Equipment, 1 year; Mining Engineer, USGS, Conservation Division, 6 years; Mining Engineer, BLM, OSPO, 2 1/2 years

Edward J. Hollowed

Job Title: Wildlife Management Biologist; Wildlife, Reclamation

Education: B.S., 1979, Wildlife Biology, Colorado State University, Fort Collins, Colorado

Experience: Wildlife Management Biologist, BLM, 5 years

Janné M. Joy

Job Title: Realty Specialist; Lands and Realty

Education: B.S., 1985, Natural Resource Management, Colorado State University, Fort Collins, Colorado

Experience: Realty Specialist, BLM, 1 1/2 years

Curtis W. Leet

Job Title: Soil Scientist; Soils, Prime and Unique Farmlands

Education: B.S., 1981, Range Ecology with minor in Soil Science, Colorado State University, Fort Collins, Colorado

Experience: Range Conservationist Trainee, Soil Conservation Service, 3 years; Soil Scientist, BLM, 6 years

Jeanette Pranzo

Job Title: Economist; Socioeconomics

Education: A.B., 1967, Economics, Hunter College, New York City, New York; M.A., 1968, Economics, University of Pittsburgh, Pittsburgh, Pennslyvania

Experience: Regional Economist, U.S. Army Corp of Engineers, San Francisco, 5 years; Regional Economist, BLM, Arizona State Office, 9 1/2 years; Economist, BLM, Colorado State Office, 9 months

Michael Selle

Job Title: WRRA Archaeologist; Cultural Resources, Paleontology

Education: B.A., 1974, Anthropology, University of Arizona, Tucson, Arizona

Experience: Volunteer, Arizona College of Technology Field School in Archaeology, 6 months; Assistant Director, Arizona College of Technology Field School in Archaeology, 9 months; Crew Member/Camp Manager, Arizona State Museum, 5 months; Area Archaeologist, BLM, 7 years

Jack Sheffey

Job Title: Area Forester; Forestry, Graphics Coordination, GIS Specialist

Education: B.S., 1977, Forestry and Wildlife, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Experience: Forestry Technician, USFS/BLM, 1 1/2 years; Forester, BLM, 5 years

Lee Stevens

Job Title: Environmental Scientist, Air Quality; Climate and Air Quality

Education: BME, 1970, Mechanical Engineering, University of Louisville, Louisville, Kentucky

Experience: Research and Design Engineer, American Standard, Inc., 5 years; Air Pollution Engineer, Jefferson County, Kentucky, 3 years; Environmental Engineer, EPA, 3 years; Environmental Scientist, USGS/MMS/BLM, 4 years

5.1.3 Support

Duane Johnson

Job Title: Environmental Coordinator; Quality Control and District Office Coordination

Education: B.S., 1969, Fisheries and Wildlife Biology, Colorado State University, Fort Collins, Colorado

Experience: District Fisheries Biologist, State of Indiana, 5 years; Environmental Engineer, Energy Fuels Company, 2 years; District Fisheries Biologist, BLM, Craig, 4 years; Environmental Coordinator, BLM, Craig, 5 years

Barbara Schmalz

Job Title: Environmental Protection Specialist; State Office Coordinator, Overall NEPA Compliance

Education: B.A., 1975, History/Sociology, Dickinson State College, Dickinson, North Dakota; M.A. (in transit), 1977, Sociology, University of Colorado, Boulder, Colorado

Experience: Sociologist, BLM, Colorado State Office, 2 years; State Office Sociologist, BLM, Colorado State Office, 4 years; Environmental Protection Specialist, BLM, Colorado State Office, 3 years

Henry C. Szymanski

Job Title: Petroleum Engineer; Technical Review of Well Drilling, Completion and Plugging Program

Education: B.S., 1982, Petroleum Engineering, Colorado School of Mines, Golden, Colorado

Experience: Oil Field Worker, Various, 1 year; Systems Manager/Programmer and Technical Report Writer for enhanced oil recovery feasibility studies, SURTEK (Exoil Services), 2 years; Petroleum Engineer, BLM, 2 1/2 years

Stephen J. Vandas

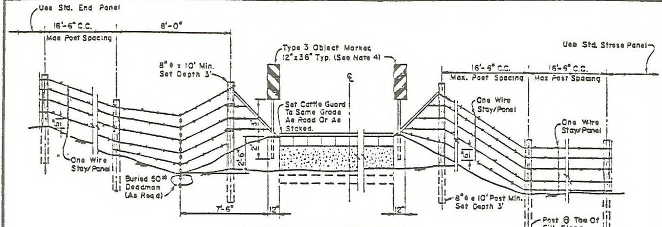
Job Title: Hydrologist; Hydrology

Education: B.S., 1975, Watershed Science, Colorado State University, Fort Collins, Colorado

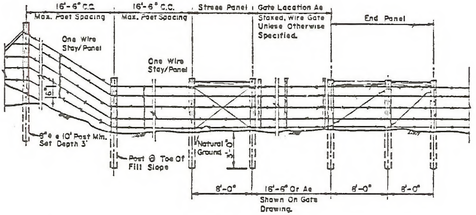
Experience: Hydrologist, USGS Water Resources Division, 1 year; Hydrologist, U.S. Bureau of Reclamation, 3 years; Hydrologist, BLM, 4 1/2 years

6. APPENDICES

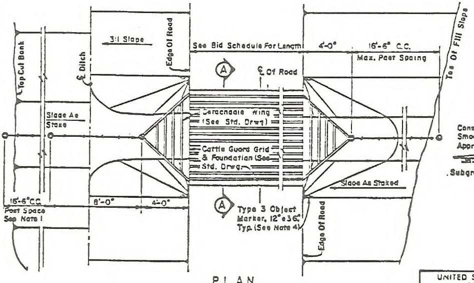
6.1 APPENDIX A - BLM TYPE "D" FENCE SPECIFICATIONS



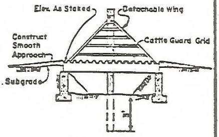
CATTLE GUARD ELEVATION



GATE ELEVATION


Top Cut Bank
℄ Ditch
3:1 Slope
Edge Of Road
See Bid Schedule For Length
4'-0"
16'-6" C.C.
Max. Post Spacing
Toe Of Fill Slope
A
℄ Of Road
Slope As Stake
Detachable Wing (See Std. Drwg)
Cattle Guard Grid & Foundation (See Std. Drwg.)
Slope As Staked
16'-6" C.C. Post Space See Note 1
8'-0"
4'-0"
A
Type 3 Object Marker, 12"x36" Typ. (See Note 4)
Edge Of Road

PLAN



SECTION A-A

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF ENGINEERING DENVER SERVICE CENTER

TYPICAL
CATTLE GUARD & GATE LAYOUT

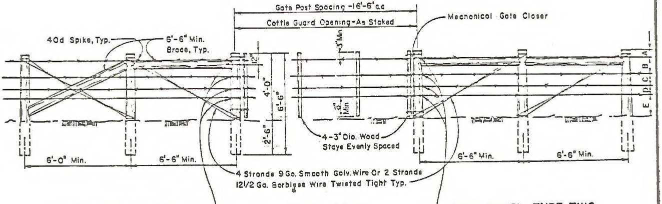
DESIGNED BY OTHERS
REVIEWED
APPROVED

DRAWN PAUL W. TWIST
SCALE N.T.S.
DATE APRIL 20, 1982
SHEET OF
DRAWING NO. 02457-5

NOTES:

1. Fence Construction Included In Each Installation Shall Be The Same As Existing Fence & As Modified Above. New Fence Shall Be As Specified In Fencing Specifications.
2. Refer To Bid Schedule And/Or Specifications For Cattle Guard Length; Type Of Cattle Guard Base & Type Of Gate If Applicable.
3. Construct Ditch As Staked.
4. Install Type 3. Object Marker When Required In The Specifications. Mount On Galv. ~ Steel Post, Min. Weight 1.33 #/Ft. AASHTO M-111 Use 3-3/16" Cadmium Plated Bolts And Nuts Per Marker.

ALWAYS THINK SAFETY


Gate Post Spacing -16'-6" c.c
Cattle Guard Opening-As Staked
Mechanical Gate Closer
40d Spike, Typ.
6'-6" Min. Brace, Typ.
3" Min.
12"
4'-0"
6'-6"
2'-6"
12" Min
6'-0" Min.
6'-6" Min.
4-3" Dia. Wood Stays Evenly Spaced
6'-6" Min.
6'-6" Min.
A
B
C
D
E
4 Strands 9 Ga. Smooth Galv. Wire Or 2 Strands 12 1/2 Ga. Barbless Wire Twisted Tight Typ.

END PANEL-TYPE ONE

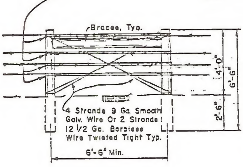
(See Specifications For Type To Be Used)

WIRE GATE

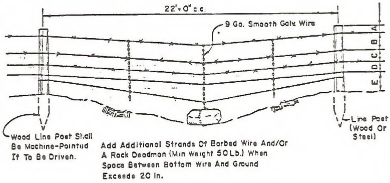
END PANEL-TYPE TWO

(See Specifications For Type To Be Used)

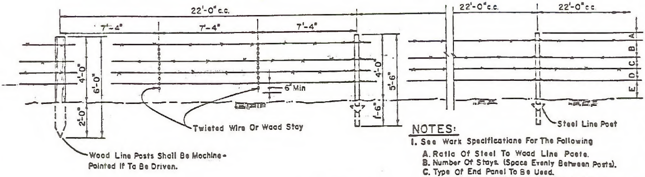
Wires To Be Tied Off At Stretch Points; Wrap And Splice To Self W/At Least 4 Turns; At Opposite End Of Stress Panel


Braces, Typ.
4'-0"
6'-6"
2'-6"
4 Strands 9 Ga. Smooth Galv. Wire Or 2 Strands 12 1/2 Ga. Barbless Wire Twisted Tight Typ.
6'-6" Min.

STRESS PANEL


22'-0" c.c.
9 Ga. Smooth Galv. Wire
A
B
C
D
E
Line Post (Wood Or Steel)
Wood Line Post Shall Be Machine-Pointed If To Be Driven.
Add Additional Strands Of Barbed Wire And/Or A Rock Deadman (Min Weight 50Lb.) When Space Between Bottom Wire And Ground Exceeds 20 In.

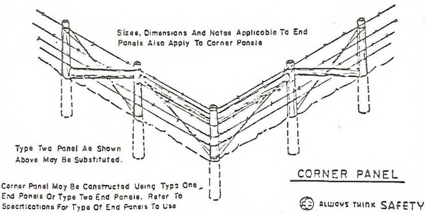
PANEL AT MINOR DEPRESSION



LINE PANELS

NOTES:

1. See Work Specifications For The Following
   - A. Ratio Of Steel To Wood Line Posts.
   - B. Number Of Stays. (Space Evenly Between Posts).
   - C. Type Of End Panel To Be Used.
   - D. Type Of Wire To Be Used For Top And Bottom Strand.
   - E. Spacing Between Strands
   - F. Type Of Gate(s) To Be Used.
   - G. Type Of End Panels To Be Used For Corner Panel To Be Used.
2. At All Junctures Of Post & Braces, Mortise 1" Deep.


Sizes, Dimensions And Notes Applicable To End Panels Also Apply To Corner Panels
Type Two Panel As Shown Above May Be Substituted.
Corner Panel May Be Constructed Using Type One End Panels Or Type Two End Panels. Refer To Specifications For Type Of End Panels To Use

CORNER PANEL

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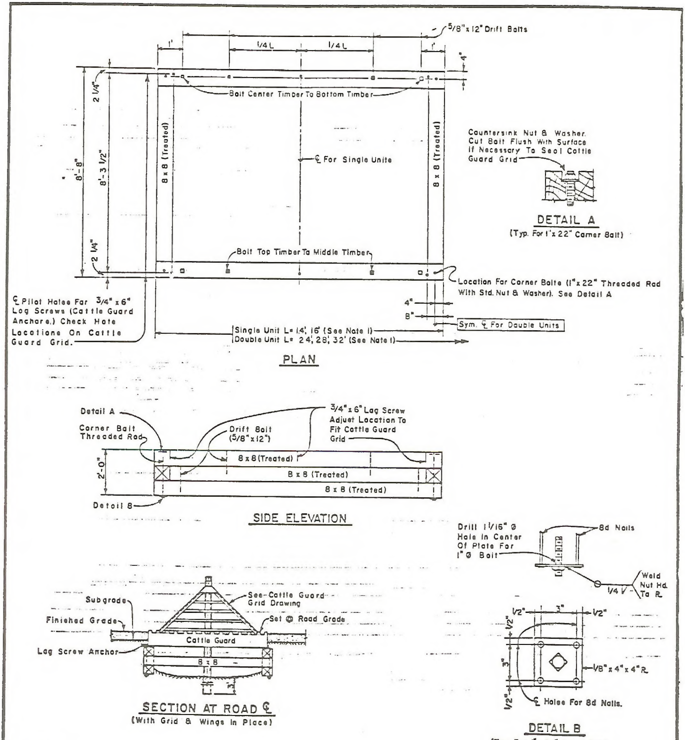
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF ENGINEERING DENVER SERVICE CENTER

BARBED WIRE FENCE
TYPE-D

DESIGNED BY OTHERS
REVIEWED
APPROVED
DRAWN PWTWIST
SCALE N.T.S
DATE APRIL 20, 1982
SHEET OF
DRAWING NO. 02445-4


5/8" x 12" Drift Bolts
1'
1/4 L
1/4 L
1'
4"
2 1/4"
8'-8"
8'-3 1/2"
2 1/4"
Bolt Center Timber To Bottom Timber
8 x 8 (Treated)
℄ For Single Units
8 x 8 (Treated)
Bolt Top Timber To Middle Timber
Location For Corner Bolts (1" x 22" Threaded Rod With Std. Nut & Washer). See Detail A
4"
8"
Sym. ℄ For Double Units
℄ Pilot Holes For 3/4" x 6" Log Screws (Cattle Guard Anchors.) Check Hole Locations On Cattle Guard Grid.
Single Unit L = 14', 16' (See Note 1)
Double Unit L = 24', 28', 32' (See Note 1)
Countersink Nut & Washer. Cut Bolt Flush With Surface If Necessary To Seal Cattle Guard Grid
Detail A
Corner Bolt Threaded Rod
Drift Bolt (5/8" x 12")
3/4" x 6" Lag Screw Adjust Location To Fit Cattle Guard Grid
2'-0"
8 x 8 (Treated)
8 x 8 (Treated)
8 x 8 (Treated)
Detail B
Drill 1 1/16" Ø Hole In Center Of Plate For 1" Ø Bolt
8d Nails
Weld Nut Hd. To R
1/4 V
1/2"
3"
1/2"
1/2"
3"
1/2"
1/8" x 4" x 4" R
℄ Holes For 8d Nails.
Subgrade
Finished Grade
See Cattle Guard Grid Drawing
Set @ Road Grade
Cattle Guard
Log Screw Anchor
8 x 8

PLAN

DETAIL A
(Typ. For 1" x 22" Corner Bolt)

SIDE ELEVATION

SECTION AT ROAD ℄
(With Grid & Wings In Place)

DETAIL B
(Typ. For 1" x 22" Corner Bolt)

NOTES:

1. See Bid Schedule For Lengths (L).
2. Cattle Guard Anchor Angles With 3/4" x 6" Log Screws With Standard Washer To Be Furnished With Each Single Grid.
3. All Timber Shall Be Of Any Western Softwood Species Graded For Posts & Timbers & Meeting Or Exceeding Construction Grade Requirements.
4. On Earth Surfaced Roads, Set Top Of Cattle Guard Eight Inches Above Subgrade Unless Plans Or Stakes Indicates Another Elevation. Taper Fill Back From Cattle Guard Approx. 50 Ft. In Both Directions.
5. Dimensions For Lumber Are Nominal Unless Otherwise Noted.

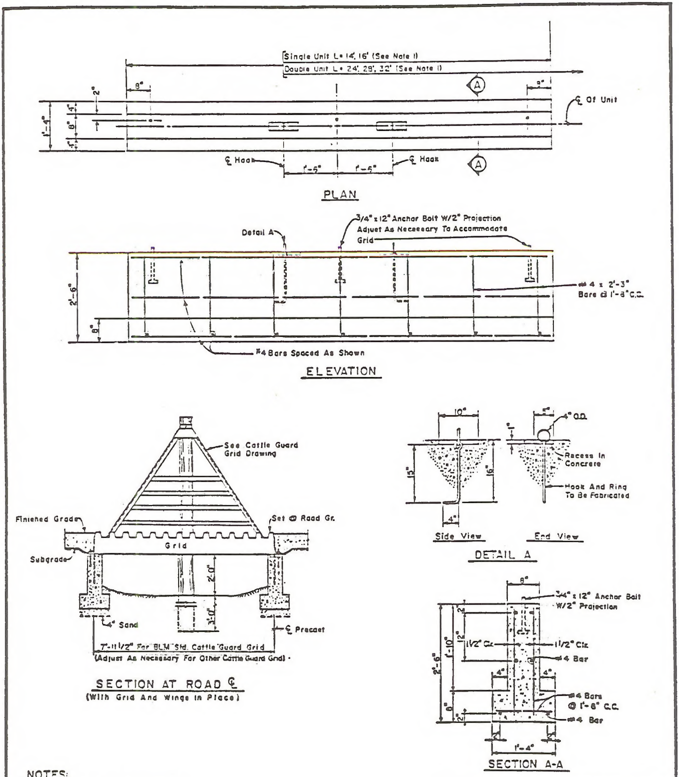
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF ENGINEERING DENVER SERVICE CENTER

CATTLE GUARD FOUNDATION
(Timber)

DESIGNED BY OTHERS
REVIEWED
APPROVED Richard E. Ewen

DRAWN JDSedillo SCALE N.T.S.
DATE APRIL 20, 1982 SHEET OF
DRAWING NO. 02457-3

ALWAYS THINK SAFETY



NOTES:

1. See Bid Schedule For Length (L).
2. Standard Nuts & Washers Shall Be Furnished With Each Foundation Unit Including Anchor Angles. Weld Or Bolt Anchor Angles To Cattle Guard.
3. On Earth Surfaced Roads, Set Top Of Cattle Guard Eight Inches Above Subgrade Unless Plans Or Stakes Indicate Another Elevation. Taper Fill Back From Cattle Guard Approx. 50' In Both Directions.

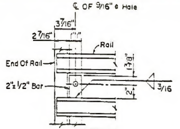
ESTIMATED QUANTITIES FOR FOUNDATION					
DESCRIPTION	QUANTITIES				
Unit Lengths	14'	16'	24'	28'	32'
Concrete	2.2 CY	2.5 CY	3.9 CY	4.4 CY	5.0 CY
#4 Reinforcing Steel	253 L.F.	299 L.F.	449 L.F.	524 L.F.	600 L.F.

ALWAYS THINK SAFETY

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF ENGINEERING DENVER SERVICE CENTER

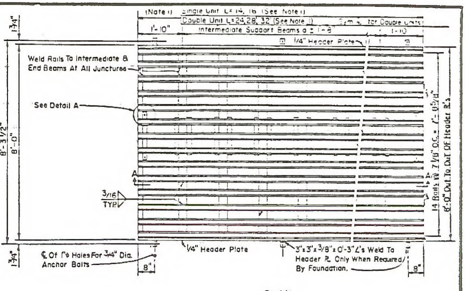
CATTLE GUARD FOUNDATION
(Precast Concrete)

DESIGNED BY OTHERS
REVIEWED
APPROVED
DRAWN J.D.Sedillo
SCALE N.T.S.
DATE APRIL 20, 1982
SHEET OF
DRAWING NO. 02457-1

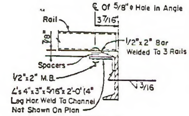


DETAIL A

(Both Ends Of 3 Rail Cleanout Similar)

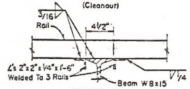

(Note 1)
Single Unit L= 14, 16 (See Note 1)
Double Unit L=24, 28, 32 (See Note 1)
Sym ℄ for Double Units
1'-10"
Intermediate Support Beams @ ± 1'-8"
1'-10"
1/4" Header Plate
1 3/4"
Weld Rails To Intermediate & End Beams At All Junctures
See Detail A
8'-3 1/2"
8'-0"
A
A
3/16 TYP
14 Rails @ 7 1/8" O.C. = 7'-0 5/8"
8'-0" Out To Out Of Header R's
1 3/4"
℄ Of 1" ⌀ Holes For 3/4" Dia. Anchor Bolts
8"
1/4" Header Plate
3"x3"x3/8"x 0'-3" L's Weld To Header R Only When Required By Foundation.
8"

PLAN

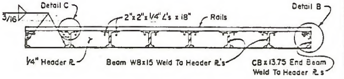

℄ Of 5/8" ⌀ Hole In Angle
3 7/16"
Rail
7/8"
1/2"x 2" Bar Welded To 3 Rails
Spacers
1/2"x 2" M.B.
L's 4"x3"x5/16"x 2'-0" (4" Leg Hor. Weld To Channel Not Shown On Plan
3/16

DETAIL B

(Cleanout)

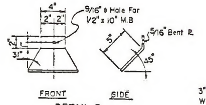


DETAIL C

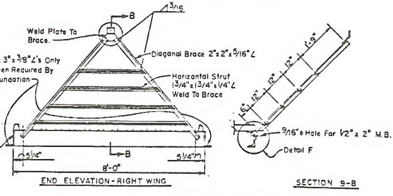

Detail C
3/16
2"x2"x1/4" L's x 18"
Rails
Detail B
1/4" Header R
Beam W8x15 Weld To Header R's
C8x13.75 End Beam Weld To Header R's

SECTION A-A

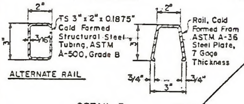
(3 Rail Cleanout)



DETAIL D

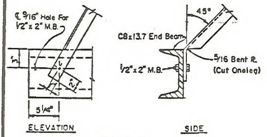

B
3/16
Weld Plate To Brace.
Diagonal Brace 2"x2"x5/16" L
3"x 3"x 3/8" L's Only When Required By Foundation
Horizontal Strut 1 3/4"x1 3/4"x1/4" L Weld To Brace
5 1/4"
B
5 1/4"
8'-0"
1/4
END ELEVATION - RIGHT WING
1'-9"
12"
12"
12"
6"
9/16" ⌀ Hole For 1/2" x 2" M.B.
Detail F
SECTION 9-8

DETACHABLE WING

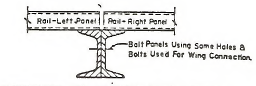

2"
TS 3" x 2" x 0.1875" Cold Formed Structural Steel Tubing, ASTM A-500, Grade B
3/16
3"
ALTERNATE RAIL
2"
Rail, Cold Formed From ASTM A-36 Steel Plate, 7 Gage Thickness
3"
3/4"
3"
3/4"

DETAIL E

(Crose Section Of Rail)



DETAIL F


Rail - Left Panel
Rail - Right Panel
Bolt Panels Using Same Holes & Bolts Used For Wing Connection.

CONNECTION FOR MULTIPLE INSTALLATION

NOTES

1. See Bid Schedule For Lengths (L).
2. All Bolts To Be Supplied With Standard Nuts & Washers.
3. Furnish Grid With Cleanout Only When Specified In The Bid Schedule.
4. Provide 4-7'-10" x 2" x 1/4" Torque Bars, Equally Spaced, Welded By 3/16 In. Fillet Welds To Top Of Rails When Alternate Rectangular Structural Tube Rails Are Provided.
5. Steel For All Componente Shall Be ASTM A-36, Unleee Indicated Otherwise On Drawing.

ALWAYS THINK SAFETY

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF ENGINEERING DENVER SERVICE CENTER

STEEL CATTLE GUARD GRID AND WINGS

DESIGNED BY OTHERS
REVIEWED
APPROVED Leonard L. Snow
DRAWN P.W. TWIST
SCALE N.T.S.
DATE APRIL 20, 1982
SHEET OF
DRAWING NO. 02457-4

6.2 APPENDIX B - AIR QUALITY SIGNIFICANCE CRITERIA

6.2 Appendix B - Air Quality Significance Criteria

Standards and guidelines have been established by both the state of Colorado and the federal government for the protection of air quality and for the definition of acceptably clean air. These standards, and their accompanying regulations focus on:

—Maintenance of ambient air quality standards
—Prevention of significant deterioration
—Determination of significant visibility impairment
—Protection of air quality related values (AQRVs)

The National Ambient Air Quality Standards (NAAQS), as well as the state of Colorado standards, which are identical, represent the absolute maximum level allowed. This means that the ambient impacts due to emissions from the WRC project, as well as those due to all existing and future projects in the region, plus the existing background ambient levels of pollutants, may not exceed these standards. The primary standards are those necessary to protect human health. The secondary standards are set at levels to protect human welfare, such as damage to crops, buildings, or other property. Table B-1 gives the NAAQS and Colorado State AAQS.

TABLE B-1

APPLICABLE STATE AND FEDERAL AMBIENT AIR QUALITY STANDARDS (ug/m^3)

Pollutant		Federal	Colorado
SO_2	(Annual)	80	80
	(24-hour)	365	365
	(3-hour secondary)	1,300	1,300
TSP	Primary		
	(Annual)	75	75
	(24-hour)	260	260
	Secondary		
	(Annual)	60	60
	(24-hour)	150	150
CO	(8-hour)	10,000	10,000
	(1-hour)	40,000	40,000
O_3	(1-hour)	240	240
NO_2		100	
Lead	(1/4-year)	1.5	

For regions that are already in attainment of the ambient air quality standards, both the state of Colorado and the federal government have established regulations for the Prevention of Significant Deterioration (PSD) of air quality. These regulations apply to particulates and sulfur dioxide (SO_2) and set limits (increments) to the increase in ambient levels of these pollutants above the existing baseline. Regions with existing clean air are divided into Class I, Class II, or Class III areas, depending on the level of additional development (and resultant deterioration of air quality) that would be allowed. Class I reflects the cleanest air and least amount of deterioration allowed. All national parks and wilderness areas are mandatory CLass I areas. Class II and Class III allow greater levels of future development and higher increments of degradation. All of the study area, with the exception of the above-mentioned Class I areas is designated Class II. However, the state or Colorado in its PSD scheme, has designated Colorado National Monument and Dinosaur National Monument as Category I. Colorado Category I carries the same increments as federal Class I. Table B-2 shows the federal and state PSD increments.

TABLE B-2

PREVENTION OF SIGNIFICANT DETERIORATION INCREMENTS

		Maximum Allowable Concentrations (ug/m^3)		
Pollutant	**Averaging Time**	**Class I/ Category I**	**Class II**	**Class III**
SO_2	Annual	2	20	40
	24-hour	5	91	182
	3-hour	25	512	700
TSP	Annual	5	19	37
	24-hour	10	37	75

Currently, there are no clear objective criteria for judging adverse visibility impairment. However, the EPA visibility regulations promulgated on December 2, 1980, (*Federal Register*, pp. 80084-80095) state that adverse visibility impairment will be determined on a "... case-by-case basis taking into account the geographic extent, intensity, duration, frequency, and time of visibility impairments, and how these factors correlate with (1) times of visitor use of the federal Class I area and (2) the frequency and timing of natural conditions." The approach taken in this study is to perform a "level 1 screening analysis," as described in the EPA document "Workbook for Estimating Visibility Impairment" (Latimer and Ireson 1980). The level 1 analysis is a technique for identifying those projects, which, based on their emissions and geographical relation to Class I areas, have a potential to generate significant visibility impairment.

Air quality related values are also related to Class I areas. These are defined as values or attributes of the environment and ecosystem that are essential to the nature of the park or wilderness area, and which may be adversely affected by degradation of the air quality. Potential air quality related values are shown in Table B-3; however, the only values that have yet been definitely identified for the Class I areas in this study are visibility, as discussed above, and acid deposition impacts of sensitive high-country lakes and watersheds. Only these AQRVs will be addressed in this study.

TABLE B-3

CATEGORIES OF POTENTIAL AIR QUALITY IMPACTS ON AIR QUALITY RELATED VALUES OF CLASS I AREAS

- Flora and Fauna Effects
  - Growth
  - Mortality
  - Reproduction
  - Diversity
  - Visible Injury
  - Succession
  - Productivity
- Soil Effects
  - Cation Exchange Capacity
  - Base Saturation
  - pH
  - Structure
  - Metals Concentration
- Water Effects
  - pH
  - Metals Concentration
  - Total Alkalinity
- Visibility Effects
  - Contrast
  - Coloration
  - Visual Range
- Odor Effects
- Cultural, Archaeological, and Geological Effects
  - Deposition
  - Decomposition

It must be emphasized that the NAAQS and PSD standards are used only as objective, scientifically established levels to which the impacts predicted from the various alternatives can be compared. BLM does not directly enforce any of these standards.

6.3 APPENDIX C - VEGETATION CONDITION AND TREND

6.3 Appendix C - Vegetation Condition and Trend

Tables C-1 through C-4 show range condition and trend of the affected vegetation associations by each alternative. The No Action Alternative shows the "existing situation." All other alternatives show acreage that is in addition to the pilot plant.

Condition—Range condition is a rating based on the seral stage of the vegetation association in relation to the potential natural plant community.

Range condition classes:

Seral Stage or Ecological Status	Percentage of the Present Plant Community that is Climax for the Range Site
Potential Natural Community, Climax (Excellent)	76-100
Late Seral (Good)	51-75
Mid Seral (Fair)	26-50
Early Seral (Poor)	0-25

Trend—The direction of change in range condition.

TABLE C-1

NO ACTION

	Condition			Trend			
Vegetative Type	Good	Fair	Poor	Improving	Static	Declining	Total
Plant Site							
Mid Elevation Sage	6.84	0.00	0	6.84	0.00	0	6.84
Low Elevation Sage	0.00	2.35	0	0.00	2.35	0	2.35
Pinyon-Juniper	0.00	4.29	0	0.00	4.29	0	4.29
Well Field							
Mid Elevation Sage	.24	0.00	0	.24	0.00	0	.24
Low Elevation Sage	0.00	3.50	0	0.00	3.50	0	3.50
Pinyon-Juniper	0.00	.20	0	0.00	.20	0	.20
Access Road							
Mid Elevation Sage	18.00	0.00	0	18.00	0.00	0	18.00
H_2O Pipeline							
Low Elevation Sage	0.00	7.00	0	0.00	7.00	0	7.00
Total							42.42

TABLE C-2

50,000 TPY ALTERNATIVE

	Condition			Trend			
Vegetative Type	**Good**	**Fair**	**Poor**	**Improving**	**Static**	**Declining**	**Total**
Plant Site							
Mid Elevation Sage	2.00	0.00	0	2.00	0.00	0	2.00
Low Elevation Sage	0.00	2.00	0	0.00	2.00	0	2.00
Pinyon-Juniper	0.00	4.14	0	0.00	4.14	0	4.14
Well Field							
Mid Elevation Sage	22.29	0.00	0	22.29	0.00	0	22.29
Low Elevation Sage	0.00	14.00	0	0.00	14.00	0	14.00
Pinyon-Juniper	0.00	56.61	0	0.00	56.61	0	56.61
Total							101.04

TABLE C-3

PROPOSED ACTION

	Condition			Trend			
Vegetative Type	**Good**	**Fair**	**Poor**	**Improving**	**Static**	**Declining**	**Total**
Plant Site							
Mid Elevation Sage	14.05	0.00	0	24.05	0.00	0	14.05
Low Elevation Sage	0.00	3.05	0	0.00	3.05	0	3.05
Pinyon-Juniper	0.00	4.18	0	0.00	4.18	0	4.18
Well Field							
Mid Elevation Sage	56.86	0.00	0	56.86	0.00	0	56.86
Low Elevation Sage	0.00	39.55	0	0.00	39.55	0	39.55
Pinyon-Juniper	0.00	122.31	0	0.00	122.31	0	122.31
Total							240.00

TABLE C-4

500,000 TPY ALTERNATIVE

Vegetative Type	**Condition** **Good**	 **Fair**	 **Poor**	**Trend** **Improving**	 **Static**	 **Declining**	**Total**
Plant Site							
Mid Elevation Sage	110.98	0.00	0	0.00	110.98	0	110.98
Low Elevation Sage	0.00	13.74	0	0.00	13.74	0	13.74
Pinyon-Juniper	0.00	37.13	0	37.13	0.00	0	37.13
Well Field							
Mid Elevation Sage	232.22	0.00	0	232.22	0.00	0	232.22
Low Elevation Sage	0.00	150.38	0	0.00	150.38	0	150.38
Pinyon-Juniper	0.00	397.62	0	0.00	397.62	0	397.62
Hillside Bunch	1.03	0.00	0	0.00	1.03	0	1.03
Total							943.10

6.4 APPENDIX D - BIOLOGICAL ASSESSMENT

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
CRAIG DISTRICT OFFICE
455 Emerson Street
Craig, Colorado 81625

IN REPLY REFER TO

1792
WRC EIS

April 17, 1986

Field Supervisor, Endangered Species Office
U.S. Fish and Wildlife Service
2078 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104

Dear Mr. Ruesink:

The following project description and attached Biological Assessment for potentially affected threatened and endangered species is submitted for your review and evaluation under Section 7 of the Endangered Species Act, and for purposes of initiating formal consultation procedures between our Agencies.

The action presented here is integral with formal consultation now being conducted for Wolf Ridge Corporation's pilot scale nahcolite solution mine. The following dates outline consultation chronology to date:

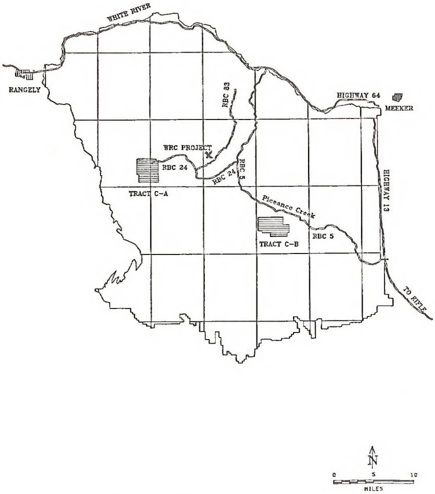
BLM request for species list	October 30, 1985
USFWS species list	November 22, 1985
BLM Biological Assessment for pilot plant	January 9, 1986
USFWS draft Biological Opinion	February 11, 1986

It is important to note that the project description and figures contained herein contain confidential-proprietary information. As such, this proprietary information is exempt from the Freedom of Information Act as described under 43 CFR 3670.0-8, and therefore, is not available for public disclosure.

BACKGROUND

The Bureau of Land Management's White River Resource Area (Craig District, Colorado) is in the process of preparing an environmental impact statement based on a mine plan submitted by Wolf Ridge Corporation for a commercial scale nahcolite solution mine in Piceance Basin, Rio Blanco County, Colorado (Figure 1).

The Wolf Ridge Corporation (WRC) presently holds four sodium leases in Piceance Basin. The leases were secured in 1971 and comprise a total of 8,222 acres. BLM determined in scoping and preanalysis that development of these leases could adversely affect the integrity of local groundwater aquifers and future minability of oil shale reserves above the nahcolite bed which WRC intends to mine. Due to the involvement of these potentially significant impacts and pursuant to Section 102 of NEPA, BLM made the decision to prepare an EIS on the mine plan.



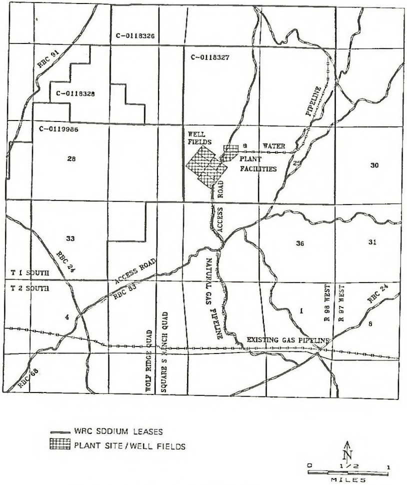
GENERAL LOCATION MAP

FIGURE 1

The WRC EIS will address three production alternatives and a no action alternative. The three production alternatives differ primarily in scale and involve mine scenarios sized to accommodate production of 50,000, 125,000, and 500,000 tons per year (tpy) of mined product over a 30-year mine life (Figures 2-7). The 125,000 TPY Alternative is the applicant's proposal. The 50,000 TPY and 500,000 TPY alternatives are BLM derived and represent the minimum and maximum production rates that a viable operation could sustain based on current economic and/or market conditions. Mining methods, transport mode, and processing facilities would be essentially the same for all three production alternatives. Areal extent of the mine field, surface disturbance, manpower and energy requirements, production water needs, and frequency of product haulage would vary in direct proportion to production rates (Tables 1 and 2). The 500,000 TPY Alternative has major operational differences in that electrical power would be gained from a commercial utility (instead of an on-site generator), and processing fuel would include coal. Coal ash would be disposed of on-site, either by filling mined out cavities with coal ash slurry or by piling ash in a designated disposal area near the facility site. Surface disposal of ash over the 30-year mine life would require approximately 11 surface acres.

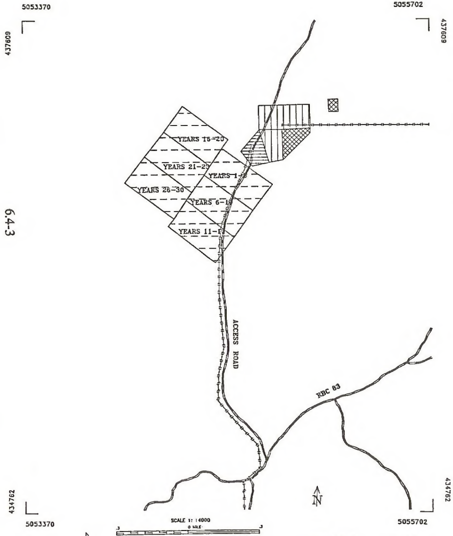
TABLE 1
FEATURE COMPARISON OF MINE ALTERNATIVES

	EIS Development Alternative		
	50,000 TPY	125,000 TPY	500,000 TPY
Operational Employment	36	45	85
Peak Construction Work Force	84	128	200
Haulage Trucks, Round Trips per Day	9	21	60
Haulage Schedule (days per week)	5 (one 10-hr shift)	5 (one 10-hr shift)	7 (two 10-hr shifts)
On-site Production Bagging and Storage	50,000 tpy	125,000 tpy	125,000 tpy
Bulk Production Load-out and Transfer	None	None	375,000 tpy
Warehouse at Lacy Station in Rifle for Bagged Product Storage and Handling	None	Yes	Yes
Power Source	On-site natural gas fired generators	On-site natural gas fired generators	Commercial 138 kV
Boiler Fuel	Natural gas	Natural gas	Coal
Auxiliary Cenerator Fuel	Diesel/natural gas	Natural gas	Natural gas
Net Energy Requirements			
Natural Cas	20,000 cu ft/hr	51,000 cu ft/hr	----------
Coal	----------	-----------	144 tons/day
Electricity	----------	-----------	5,500 kvh
Water Consumption Rate	80 gpm	150 gpm	600 gpm
Annual Water Consumption	117 ac-ft/yr	219 ac-ft/yr	875 ac-ft/yr



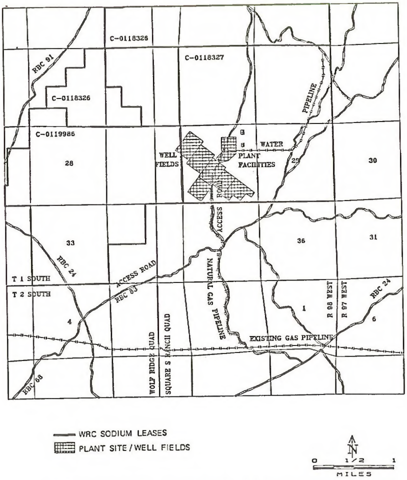
50,000 TPY ALTERNATIVE

FIGURE 2



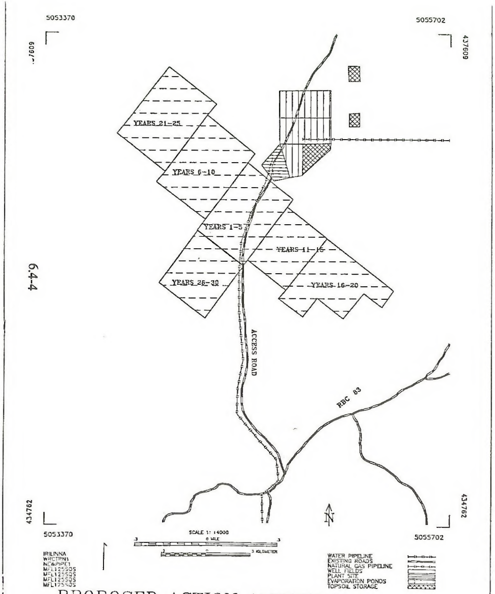
50,000 TPY ALTERNATIVE

FIGURE 3



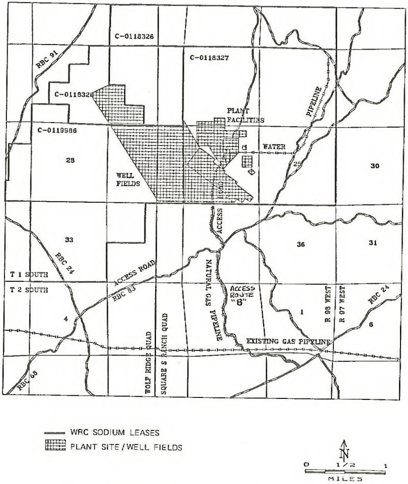
PROPOSED ACTION ALTERNATIVE
(125,000 TPY)

FIGURE 4



PROPOSED ACTION ALTERNATIVE
(125,000 TPY)

FIGURE 5



500,000 TPY ALTERNATIVE

FIGURE 6

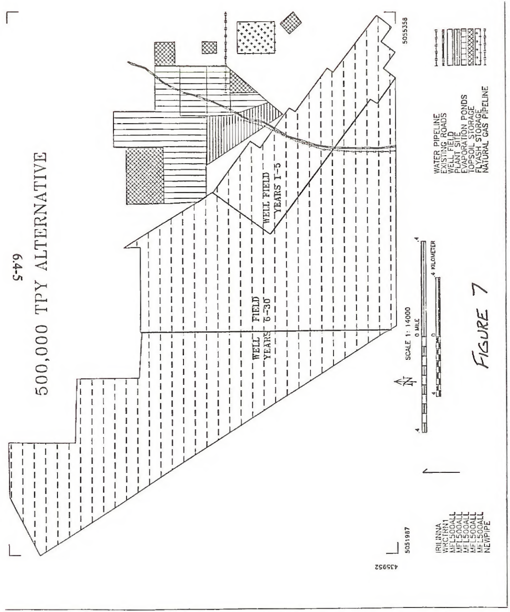


FIGURE 7

TABLE 2

WELL FIELD OPERATION AND SURFACE DISTURBANCE STATISTICS

Subject	EIS Development Alternatives a/ 50,000 TPY 300'	 50,000 TPY 600'	 125,000 TPY 300'	 125,000 TPY 600'	 500,000 TPY 300'	 500,000 TPY 600'
Well pairs operated simultaneously	2	1	3	2	12	8
Additional well pairs equipped concurrently on standby	2	1	3	2	12	8
Wells drilled annually	10	6	22	12	88	44
Wells drilled over 30-year mine life	270	136	660	330	2,640	1,320
Initial well field disturbance in acres (preparative)	3	2	7	4	28	16
Annual surface disturbance in well field (ac)	2	1	5	3	18	11
Well field disturbance over mine life (ac)	66	38	154	88	564	322
Proportion of well field disturbed over mine life (%) b/	70	40	70	40	70	40
Total processing and facility site acreage (life of mine)	10	10	12	12	62	62
Total evaporation pond acreage (life of mine)	15	15	27	27	93	93
Total "permanent" disturbed acreage (over life of mine)	25	25	39	39	155	155
Total surface disturbance over mine life, discounting reclamation (ac)	91	63	193	127	719	477

a/ The two columns under each alternative represent minimum and maximum distances separating the two wells comprising a well pair.

b/ See Figure 8.

The No Action Alternative represents denial of commercial lease development. It would involve no additional mining beyond the small scale pilot plant project which was the subject of formal consultation initiated January 9, 1986 and culminated the draft Biological Opinion of February 11, 1986.

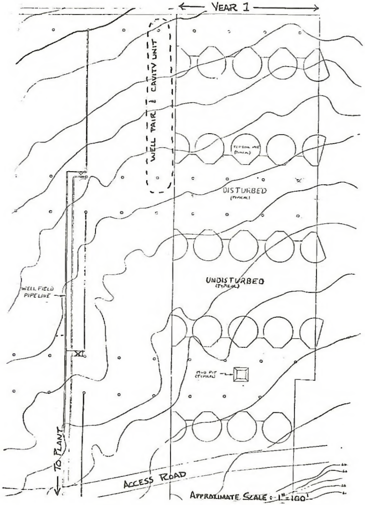
DESCRIPTION OF THE PROPOSED MINE PLAN

Mining Method

WRC proposes in situ solution mining of the Boies Bed, a rich, relatively pure layer of nahcolite (sodium bicarbonate) 1,900 feet below the surface. The basic solution mining technique involves drilling two wells into the Boies Bed 300 to 600 feet apart, establishing communication between wells by drilling horizontally from each well and circulating hot water between the well pairs to dissolve the nahcolite (Figures 8 and 9). Mining would ultimately create a subsurface cavity approximately 26 feet high, 58 feet wide, and 300 feet long. The saturated solution would then be pumped back to the surface, piped to the process facility, recrystallized, dried, and trucked to Rifle's Lacy Station for rail shipment.

FIGURE 8

TYPICAL WELL FIELD LAYOUT



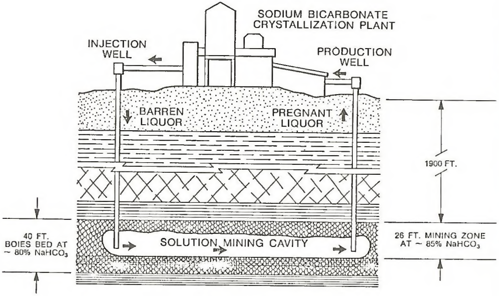

SODIUM BICARBONATE CRYSTALLIZATION PLANT
INJECTION WELL
PRODUCTION WELL
BARREN LIQUOR
PREGNANT LIQUOR
1900 FT.
40 FT. BOIES BED AT ~ 80% NaHCO₃
SOLUTION MINING CAVITY
26 FT. MINING ZONE AT ~ 85% NaHCO₃

FIGURE 9 General Solution Mining Diagram

Well field development would consist of parallel series of well pairs spaced on 72 feet centers. Each "line" of well pads would be separated by 300 to 600 feet, depending on the accuracy of horizontal drilling alignment.

Well field operation requires that a number of wells be drilled and equipped for production simultaneously in order to guarantee a steady feed rata of nahcolite solution to the process plant, and also have "stand-bys" available to replace depleted mining cavities. Table 2 details specific well field operation statistics based on well spacing and production rate.

At this time, WRC intends to mine only the Boies Bed, a 30-foot zone of bedded nahcolite. Once WRC begins mine operation and gains experience with solution mining techniques, they hope to initiate a long-term research program to explore means of economically extracting thinly bedded nahcolite reserves throughout the sodium lease tracts. Authorization for this activity would be sought by WRC in future modifications to their mine plan.

Process Facilities

Life of mine process facilities would occupy from 50 to 125 acres depending on the production rate alternative (Table 2). Commercial facilities would consist of multiple evaporation ponds, water storage tanks, crystallizers, dryers, and load out facilities, and steel buildings housing plant process equipment, laboratory, offices, boilers, electric generators, and compressors. All equipment and buildings would be erected over bermed asphalt or concrete slabs. The evaporation ponds would receive waste water from all phases of product processing and any contaminated runoff from the facility area. All evaporation ponds would be double-lined with an impervious membrane, and installed with leak detection systems.

Operating Schedule

Regardless of alternative, the mine would operate 330 days per year, 7 days per week, 24 hours per day over the 30-year mine life. Thirty-five days per year of down time is scheduled for equipment maintenance and repair.

Shift schedules are anticipated to be three 8-hour shifts per day. Product transport by 26-ton haul trucks would vary depending on alternative, as would employment needs (Table 1).

Access

Plant site access would be provided by upgrading a 3.3-mile segment of existing unimproved road. A 60-foot wide right-of-way would accommodate the road bed, ditches, and slopes from the plant site to the paved Ryan Gulch Road (RBC 24). The 36-foot wide road surface would be graveled under the 50,000 TPY Alternative, and paved in both the 500,000 and the 125,000 TPY alternatives. This access route is shown in Figure 2.

Utilities

A natural gas fired cogeneration unit would provide all electric power required for nahcolite processing and plant operation in the 50,000 and 125,000 TPY alternatives. Natural gas and/or diesel would fuel boilers and auxiliary generator units.

In the 500,000 TPY Alternative, electric power would be provided by a commercial utility, involving new construction of a 138 kV transmission line in Piceance Basin. Coal would replace natural gas or diesel as boiler fuel. It is estimated that 144 tons per day of coal would be used, requiring about six additional round trip truck loads per day.

Water Consumption

Processing and potable water would be obtained from water well(s) located in the lease vicinity. Water consumption rates for the 50,000 and 125,000 TPY alternatives would be 80 gallons per minute (gpm) (117 acre-feet/year) and 150 gpm (219 ac-ft/yr), respectively. Water would be pumped to the facility through a buried pipeline, and stored in a 75,000-gallon head tank.

In the event the 500,000 TPY Alternative were selected, a second water well would need to be constructed. Location of this well is uncertain at this time. Total consumptive annual water use under this alternative would be about 875 acre-feet/year based on a rate of 600 gpm and 330 day/year operating schedule.

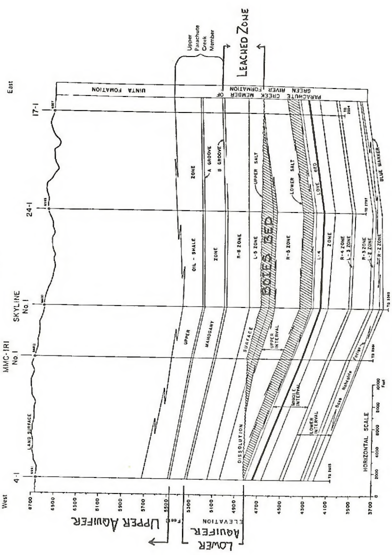
Rock Mechanics, Groundwater Hydrology

One of the major reasons an EIS was prepared on this action was the Bureau's concern for mining's influence on the future minability of associated oil shale deposits and, more important to wildlife, the integrity of affected groundwater aquifers.

The principal bedrock aquifers that occur in the project area are commonly referred to as the upper and lower aquifers (Figure 10 shows generalized geologic cross-section). These two aquifers are separated by the Mahogany Zone. Because its high kerogen content lends plastic properties to the rock, the Mahogany Oil Shale Zone is generally less susceptible to fracturing than surrounding rock and often allows very little communication between aquifers. In the project area, however, natural dissolution of sodium minerals in the intervals subtending the Mahogany (leached zone) have caused movements due to collapse of supporting strata. For this reason, the Mahogany Zone within the leases is believed to be fractured, allowing aquifer intercommunication.

The base of the lower aquifer lies on bedded nahcolite which forms the Boies Bed (as part of the Saline Zone). The interface between the lower aquifer and Saline Zone is termed the dissolution surface, where active dissolution of salts is an ongoing process.

Both aquifers discharge to Yellow and Piceance creeks either directly from springs or indirectly through alluvial aquifers which then discharge to the surface. It has been estimated that up to 80 percent of these streams' total base flow is attributable to groundwater discharge. Piceance Creek is generally perennial for its entire length, whereas, Yellow Creek is historically perennial only in its upper reaches and its lower extremity (final 2 to 3 miles).



Structural Cross Section W - E Through the Wolf Ridge Corp. Lease Area.

FIGURE 1D GEOLOGIC X SECTION

The creation of a network of vacant mine cavities in the Boies Bed would likely result in progressive vertical caving, fracturing, or subsidence of overlying strata and could affect the integrity or quality of the lower aquifer. Rock formations overlying the proposed mining zone could be affected in two ways. First, collapse of cavity roofs could result in caving of overlying formations into the cavity. The effect of this caving would extend upwards until the cavity was bulked full (predicted upper limit: 53 feet above the cavity roof). BLM believes that at least some caving would extend through the dissolution surface into the lower portion of the lower aquifer, but these effects would not involve the Mahogany Zone.

Secondly, subsidence of overlying formations could occur as a result of the pillars between cavities failing and crushing to a certain extent. The loading on the pillars will be such that some crushing (failure) at the tops of the pillars can be expected. The lessee estimated a total downward movement of less than 1 foot. This movement will cause subsidence of overlying formations with the potential of reaching all the way to the surface. Significant fracturing could occur in the formation immediately overlying the cavities in the leached zone, but these movements are not expected to result in significant fracturing of the Mahogany Zone.

Thus, proposed mining is not expected to significantly affect the Mahogany Zone nor its role in more or less segregating upper and lower aquifer waters. Even in the event that fracturing were to increase aquifer intercommunication, no groundwater impacts would be expected since upper portions of the lower aquifer and lower portion of the upper aquifer have similar water quality characteristics.

Impacts to lower aquifer water quality are likely to occur as the result of cavity roof collapse and subsidence. It is likely that the roof collapse zone and subsidence induced fracturing will reach the base of the lower aquifer and thereby establish communication between the relatively fresh water of the lower aquifer and the brine solution remaining in the mine cavities.

There would be a natural tendency for the brines to remain isolated from the fresh water as the denser, more viscous brines should remain ponded in the cavities with the lighter, less viscous fresh water tending to remain floating on top.

Without extraordinary physical influences (e.g., rapid caving or subsidence), mixing of these waters would occur primarily by diffusion. Diffusion and other processes currently occurring at the dissolution surface take place at very low rates and it is expected that gradual cavity bulking and subsidence would mimic this natural process.

The major difference between alternatives as they potentially affect groundwater quality is the number and location of mine cavities. As the number of cavities created increases, the risk of contact between lower aquifer water and cavity brines increases because of relative numbers (incidents of roof collapse) and the fact that as the well field expands from the 50K to 500K alternatives, relatively more cavities will be located near the fringe of the Boies Bed where the cavity roofs would be increasingly closer to the base of the lower aquifer.

It is estimated that if all cavities were to collapse over the life of the mine, the base of the lower aquifer now thought to be in contact with the Saline Zone would increase in areal extent by 0.5, 1.0, and 4.0 percent for the 50K, 125K, and 500K TPY alternatives, respectively.

More severe impacts to lower aquifer water quality would occur in the unlikely event of a catastrophic roof collapse. Rapid roof caving taking place within several hours time would cause turbulent flow at the base of the lower aquifer. The result of such an event would be rapid and thorough mixing of relatively fresh aquifer water and cavity brines, and presumedly a pulse of high TDS water (up to 140,000 mg/l) carried through the lower portion of the lower aquifer. This potential impact will be mitigated by requiring that a certain number of wells be permanently dedicated to groundwater monitoring. The number of permanent monitoring wells needed will vary by alternative, depending on the size of the well field. If the groundwater monitors detect brine entering the groundwater system, remedial action would be required. These remedial actions would be designed to isolate the brine from the rest of the aquifer system. Techniques that could be used include for example, pumping of the brines from the cavities for disposal on the surface.

BIOLOGICAL ASSESSMENTS

The species considered in the assessment are based on a list obtained on request from the USFWS Field Office in Grand Junction, Colorado (November 22, 1985). Analyses for terrestrial species are similar to those presented in the WRC pilot plant Biological Assessment of January 9, 1986.

Black-Footed Ferret

No past or recent evidence exists which indicates occupation of Piceance Basin by ferret. In this region white-tailed prairie dogs are considered to be the ferret's preferred prey--known ferret distribution being closely coincident with that of prairie dog towns. This office is not aware of any white-tailed prairie dog towns in the basin proper. The closest BLM recorded town exists 15 miles north and 7 miles west of the proposed mine on Stadtman Mesa. No evidence of prairie dogs was found during on site inspection of the project area in the summer of 1985.

Commercial scale sodium development, regardless of alternative, would not involve potential ferret habitat and would pose no conceivable threat to ferret populations.

Endemic Colorado River Fishes, including: Colorado Squawfish, Humpback Chub, Bonytail Chub, Razorback Sucker

Of the listed and candidate species above, only the Colorado squawfish is documented as occurring in the White River. Until recently, the squawfish inhabited the White River from its confluence with the Green River upstream to the mouth of Piceance Creek (RM 148.2). With the closing of Taylor Draw Dam in November 1984, squawfish distribution is generally confined downstream of the dam (RM 104.2).

All the subject fishes have known downstream populations in the Green River and Colorado River above Lake Powell. Each of these species seem to share a

requirement for riverine backwater areas for larval development (nursery areas) and respite from periods of high flow.

At the least, the apparent importance of the White River to endemic fish in the Upper Colorado River Basin is its flow contribution to the Green River. It is believed that major Green River tributaries, such as the White River, exert a strong influence on the reproductive success of endemic fishes known to spawn downstream.

The WRC nahcolite mine is situated in the approximate center of the Yellow Creek drainage, about 19 miles south of the White River. Yellow Creek empties into the White River at RM 132.3. Thus, the principal distribution of squawfish is separated from direct project influence by a 19-mile segment of Yellow Creek and its tributaries, and a 28-mile segment of the White River.

Minings groundwater involvement will affect certain surface water parameters which are thought to have a direct influence on the suitability of downstream fisheries (i.e., turbidity, total dissolved solids (TDS), and flow regimes).

BLM expects minor, localized increases in sediment transport from active portions of the well field. During spring runoff and high intensity rainfall events, sediment may reach Yellow Creek and thence the White River, but relative to Yellow Creek's normal sediment yield the increase would be negligible. Prompt rehabilitation and erosion control measures will be employed on all disturbed areas as stipulated in the EIS.

With the incorporation of water containment and handling procedures submitted in WRC's mine plan, as well as additional BLM-specified measures, there will be no reasonable likelihood of measurably increasing TDS concentrations of surface and groundwater supplies due to spills or leaks. Solution mining operations, in-field transport and storage of fluids, and nahcolite processing will be subject to intensive downhole and surface monitoring, including clean-up contingencies for accidental well casing and pipeline failures.

Geologic impacts associated with mining could result in small future TDS increases in both ground and surface waters. The eventual collapse of all or some cavity roofs will likely increase the areal interface between the lower aquifer and salt zone. This would probably accelerate the natural dissolution process and could ultimately increase salts contributed to the White River via Yellow and Piceance creeks. Increased salt concentrations originating from the dissolution surface could appear in Piceance and Yellow creeks' flows in 200 to 1,000 years. It is believed that any TDS increases in the White River would be very small; unlikely to exceed 1 percent for the 500,000 TPY Alternative (about 1.5 mg/l in White River near CO-UT border). This increase in salt concentration may never occur if sufficient dilution occurs during migration of the salt through the groundwater system.

Maintenance of flow volume and periodicity in the White River, as part of the Colorado River system, is considered paramount in protecting downstream habitat of all candidate and listed fishes in the Green and Colorado rivers. Any consumptive use of water obtained from the Upper Colorado River Basin is considered an ultimate depletion of flow from this river system. Based on this premise, BLM is aligned with the opinion that incremental and cumulative depletion of flow is detrimental to downstream aquatic conditions constituting suitable habitat for listed and candidate fishes (e.g., decreasing the extent and availability of required backwater habitats).

Pumping of upper aquifer groundwater for solution mining and product processing will reduce Piceance and Yellow creeks' flow contributions to the White River. The initial affect of drawdown will appear within 3 years of first pumping, gradually reaching maximum depletion values (Table 3) at end of mine life. Depletions will gradually subside for up to 20 years beyond end of mine life as the upper aquifer recharges.

TABLE 3
WATER QUANTITY IMPACTS

	Alternatives		
	50,000	125,000	500,000
Effective rate of groundwater consumption (cfs) a/	0.16	0.30	1.21
Maximum rate of flow depletion from Yellow Creek (cfs)	0.04	0.09	0.41
-- Percent average daily flow	2.0	5.0	23.0
Maximum rate of flow depletion from Piceance Creek (cfs)	0.04	0.15	0.71
-- Percent average daily flow	0.1	0.4	2.0
Total depletion relative to White River's lowest recorded flow (%) b/ d/	0.26	0.48	1.95
Total depletion relative to White River's average recorded flow (%) c/ d/	0.03	0.05	0.19

a/ Assuming 330 days per year operation.
b/ 62 cfs, USGS station above Rangely, CO; July 1977.
c/ 633 cfs, USGS station above Rangely, CO; 1973 to 1981.
d/ Assuming entire volume of water pumped from upper aquifer ultimately appears as a depletion of surface flow in the Upper Colorado River Basin.

Even though groundwater consumption rates for any alternative are not expected to measurably alter the White River's flow (particularly the 50,000 or 125,000 TPY alternatives, Table 3), BLM maintains that such depletions would contribute to adverse alteration of habitats used by listed and candidate fishes. BLM defers the assessment of significance of each alternative's depletion to the USFWS.

CANDIDATE WILDLIFE SPECIES

Ferruginous Hawk

Ferruginous hawks are well distributed, but rather uncommon breeding residents in the juniper saltbush associations near Rangely, Colorado, about 25 miles northwest of the project area. The birds appear in this region in late February, quickly occupying breeding territories and attending to nest activities. By early to mid-September most hawks have begun southward migration, although individual birds have been noted in mid-winter along Highway 40 west of Elk Springs, Colorado. Rarely are ferruginous hawks observed in Piceance Basin outside migration. The basin generally lacks

preferred nesting habitat, being more heavily forested (pinyon-juniper woodland), brushy, and lacking broad nest site vistas. BLM is not aware of any nesting attempts in Piceance Basin. Development of any of the nahcolite solution mine alternatives should not adversely affect ferruginous hawk or associated habitats.

Swainson's Hawk

Swainson's hawks are uncommon, and perhaps irregular, breeding residents in the rolling, sagebrush-mountain shrub type in the Great Divide area, northwest of Craig, Colorado and to a lesser degree in the juniper-saltbush association near Dinosaur, Colorado (northwest of Rangely) and Coyote Basin, Utah. A pair of birds observed on three occasions during the summer of 1977 on Oak Ridge, about 10 miles southeast of Meeker, indicated a potential for nests in transitional shrub areas bordering agricultural lands. The BLM is unaware of any nest records coming from Piceance Basin, and consider it highly unlikely in the basin's interior pinyon-juniper woodland types. Summer observations of Swainson's hawks have not appeared in the many raptor inventories conducted during baseline oil shale development studies.

Swainson's are noted irregularly during migration at higher elevations east of Meeker in the White River National Forest. BLM assumes these birds appearance in Piceance Basin would be migration-related.

Swainson's hawks and their seasonal habitats are not expected to be impacted by mine development.

Long-Billed Curlew and White-Faced Ibis

Long-billed curlew prefer open plains, agricultural land, and marshy areas for feeding, and open prairie for nesting. Curlews are rare, irregular migrants in the area. Individual birds have been seen at Rio Blanco Lake (April 19, 1980) and at the mouth of Ryan Gulch on Piceance Creek (May 1981). Habitat considered suitable for curlew nesting is nonexistent in the mine development area. Nearest migration-related use may occur in riparian/agriculture habitats associated with the mainstems of Yellow Creek (3 miles west of project) and Piceance Creek (3.5 miles east of project).

White-faced ibis occur in the region as an uncommon migrant. Flocks of up to 50 birds (generally 6-24) are encountered regularly along the White River and Piceance Creek during April and May, but can be expected to appear in any suitable habitat in the region (including the mainstem of Yellow Creek). Ibis prefer shallow lake or pond margins, wetlands, and irrigated meadows for feeding.

Regardless of alternative, aquatic and wetland vegetation supported by Piceance Creek would not be measurably influenced by the small degree of base flow reductions effected by groundwater pumping (Table 3).

The small amount of aquatic and wetland vegetation borne by lower Yellow Creek (less than 1 acre) would remain essentially unaffected by base flow reductions associated with the 50,000 TPY Alternative. Under the 125,000 TPY Alternative, no appreciable change in the extent or distribution of aquatic/wetland vegetation would be expected during years of normal snowpack and precipitation. During dry years, spring and early summer flows would remain relatively unchanged, but 20 to 40 percent reductions could be expected from July through September. These conditions would probably lead to minor constrictions (up to 10 percent) of wetland and riparian fringe areas.

Groundwater use associated with the 500,000 TPY Alternative would likely induce notable flow reductions in lower Yellow Creek. Early summer flow reductions could average 20 to 40 percent through June, increasing to 60 percent by August. During dry years 70 to 80 percent reductions could be expected by June, with flow essentially absent from July through September. Flow reductions and periodic drying of the channel would reduce consistent support of aquatic and wetland communities in affected portions of Yellow Creek. Wetland extent and quality would gradually deteriorate over mine life, reaching maximum loss at end of mine life and persisting for at least 20 years beyond end of mine life. Wetland and aquatic resource losses in Yellow Creek, although long term, are very small in areal extent and are considered completely reversible.

Thus, the 125,000 and 500,000 TPY alternatives would likely involve losa and modification of less than 1 acre of potential ibis/curlew migratory habitat. This loss would not conceivably affect transient bird populations.

CANDIDATE PLANT SPECIES

Physaria obcordata (Piceance twin pod)

This species occurs on sparsely vegetated, decomposed Green River shale barrens. This species has been found on Calamity Ridge, 15 miles northwest of the mine site and Piceance Creek proper between Ryan Gulch and Black Sulphur Creek, 5 miles southeast of the mine site. No potentially suitable habitat exists in the project area. These populations would not be directly or indirectly impacted by any mine-related activity.

Festuca dasyclada (sedge fescue)

This species occurs on talus slopes associated with Uinta Formation sandstones and Green River Formation shales. Plants are typically found at the bases of slopes in narrow, moderately to steeply sloped draws. Known distribution is limited to the upper portions of Piceance Basin, that is, the southern third of the Piceance triangle (10-20 miles southeast of the project area) and the Roan Plateau (20 plus miles south).

The species growth habit implies weak grazing tolerance, never having been found in areas subjected to moderate or heavy grazing pressure. Since the WRC project is far removed from any known population of F. dasyclada, and the gently rolling topographic nature of the area lends itself to unrestricted ungulate grazing, it is highly improbable that the species is established in the area of concern.

Lesquerella parviflora and L. congesta (Piceance bladderpods)

L. parviflora is found on Green River shale ledges and alopes of canyona on the Cathedral Bluffs, Calamity Ridge, and Piceance Creek between Ryan Gulch and Thirteenmile Creek. The closest known plant population occurs 5 miles southeast of the mine site.

Similarly, L. congesta occurs on barren shale slopes associated with outcrops of the Green River Formation. The species has been documented from Piceance Creek proper (4 miles southeast of the project area), mainstem Duck Creek (5 miles northwest), and a major unnamed tributary of Yellow Creek (3 miles northeast).

Potentially suitable Lesquerella habitats do not exist within the scope of the 50,000 or 125,000 TPY alternatives. Approximately 1 acre of possibly suitable, but unoccupied habitat (barren shale slope) occurs on the edge of the 500,000 TPY well field. In the event the 500,000 TPY Alternative were selected, the loss of up to 1 acre of potentially suitable habitat would not adversely affect these plant's continued conservation.

SUMMARY

In conclusion, BLM finds that terrestrial threatened and endangered (listed or candidate) plants and animal populations would not be affected or influenced by WRC's mine development alternative in Piceance Basin.

We believe that the quantity of groundwater supplies which the applicant requires would not in itself measurably deplete or alter the White River's flow characteristics. However, we maintain the assumption that it does constitute an increment of cumulative depletion of the Colorado River system, and is at least one factor contributing to the decline of the Colorado's endemic fish populations. Increments of depletion and cumulative impacts to endangered fish habitats would, of course, grow progressively worse with increasing rates of water consumption.

In the event new data becomes available involving mining methodology, impact analysis, or groundwater monitoring which could result in different outlooks concerning threatened and endangered species conservation, BLM would notify your office immediately and initiate supplemental Section 7 consultation. If you require further information or clarification on this project or the biological assessments, please contact Ed Hollowed, or Willy Frank at the White River Resource Area in Meeker (AC 303-878-3601).

Sincerely,

/s/ William J. Pulford

William J. Pulford
District Manager

6.5 APPENDIX E - TERMS AND CONDITIONS OF THE SODIUM LEASES

6.5 Appendix E - Terms and Conditions of Sodium Leases

Excerpts from Wolf Ridge Corporation Sodium Leases C-0118326, C-0118327, C-0119986, and C-37474 (with the exception of redefined legal descriptions of the leases)

Definitions. The following definitions shall be used in the interpretation of this lease:

(a) "Oil shale" is a fine-grained sedimentary rock containing organic matter which was derived chiefly from aquatic organisms or waxy spores or pollen grains, which is only slightly soluble in ordinary petroleum solvents, and of which a large proportion is distillable into artificial petroleum. This term is applicable to any argillaceous, carbonate, or siliceous sedimentary rock which will yield oil upon destructive distillation.

(b) "Saline Zone" as used in this lease means the lower part of the Parachute Creek Member of the Green River Formation in the Piceance Creek Basin, the top of which zone is defined at any point by the characteristic "dissolution surface," and the bottom of which is defined at any point by the horizon marker designated as the "Blue Marker," which "Blue Marker" forms the approximate base of the Parachute Creek Member; and

(c) "Leased deposits" means (1) all sodium compounds (and any related products thereof) in the Saline Zone not intermingled with oil shale averaging 25 gallons of shale oil or more per ton of rock mined (hereinafter referred to as "25 G.P.T. Oil Shale"), such average to be determined monthly for each calendar month by modified Fischer assays of the rock mined by lessee for processing or beneficiation by any method, and (2) all sodium compounds (and any related products thereof) within the Saline Zone which are intermingled with 25 G.P.T. Oil Shale and which can be mined, extracted, processed, beneficiated, used, and disposed of without the destructive distillation of the 25 G.P.T. Oil Shale and without significantly changing the composition of the 25 G.P.T. Oil Shale or rendering it more unsuitable in any material respect for development, retorting, processing, use, or disposition. As used herein, the term "related products" shall, in no event, include oil shale.

WITNESSETH:

Sec. 1. Rights of lessee:

(a) The lessor, except as otherwise provided in the lease, does hereby grant and lease to the lessee the exclusive right and privilege to mine, extract, process, beneficiate, use, and dispose of all the leased deposits in the Saline Zone in or under the following-described tracts of land, situated in the County of Rio Blanco, State of Colorado:

Based upon the resurvey dated 8/1/44 and the reestablishment dated 1/3/83 of Township 1 South, Range 98 West.

C-0118326

Township 1 South, Range 98 West, 6th Principal Meridian
Section 13: All
Section 14: All
Section 15: Lots 1 to 13 inclusive
Section 21: NE1/4NE1/4, S1/2NE1/4, NE1/4SW1/4, SE1/4
Section 22: Lots 12, 13, and 14
Total area = 2,159.64 acres

C-0118327

Township 1 South, Range 98 West, 6th Principal Meridian
Section 23: All
Section 24: All
Section 25: All
Section 26: All
Total area = 2,483.16 acres

C-0119986

Township 1 South, Range 98 West, 6th Principal Meridian
Section 21: S1/2SW1/4
Section 27: All
Section 28: All
Section 29: SE1/4NE1/4, S1/2S1/2, NE1/4SE1/4
Section 33: All
Section 34: Lots 3, 4, 5, and 6
Total area = 2,379.60 acres

C-37474 (out of C-0119985)

Township 1 South, Range 98 West, 6th Principal Meridian
Section 16: N1/2NE1/4, SW1/4NE1/4, W1/2, NW1/4SE1/4
Section 17: All
Section 20: NE1/4NE1/4
Section 21: NW1/4NW1/4
Total area = 1,200.00 acres

containing [8,222 acres,] more or less, together with the right, subject to the applicable regulations and the requirements imposed thereunder, to construct all such works, buildings, plants, structures, and appliances as may be necessary or convenient for the mining, processing, and preparation of the leased deposits for market and the housing and welfare of employees and, subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted for a period of 20 years from the effective date of this lease (July 6, 1971), and the lessee shall have a preferential right to renew this lease for successive periods of 10 years under such reasonable terms and conditions as may be prescribed by the Secretary of the

Interior, unless otherwise provided by law at the expiration of any period as provided in Sec. 3(d) hereof.

(b) Except as expressly provided in subsections 1(c), (d), and (e), the lessee shall not (1) mine, extract, retort, process, use, or dispose of any oil shale, or organic matter or the products thereof contained in or derived from any such oil shale, situated above or below the Saline Zone in the above-described tracts of land, (2) mine, extract, retort, process, use, or dispose of any 25 G.P.T. Oil Shale, or organic matter or the products thereof contained in or derived from any such 25 G.P.T. Oil Shale, situated in said Saline Zone, or (3) use, remove from the leased premises or dispose of any oil shale, or organic matter or the products thereof contained in or derived from any such oil shale, averaging more than 10 gallons of shale oil per ton from said Saline Zone, such average to be determined by modified Fischer assays of that material. It is expressly understood and agreed that the lessee shall not have any right to, and shall not, burn or otherwise use for fuel or energy production purposes, any oil shale situated in or under the lands described in Sec. 1(a) hereof.

(c) The lessee shall have the right and privilege (1) to mine and extract oil shale or other material located above the Saline Zone for the sole purpose of emplacing such shafts or other entries as are necessary and are authorized by the Regional Mining Supervisor to gain access to the leased deposits for mining, extraction, and removal operations, and (2) to mine, extract and process by nonretorting methods, which are chemical or mechanical and do not require the use of heat, 25 G.P.T. Oil Shale intermingled with the leased deposits, but only to the extent necessary for and as an incident to the mining, extraction, processing, beneficiation and removal of the leased deposits, and only so long as in the opinion of the Regional Mining Supervisor, there is no significant extraction or removal of the 25 G.P.T. Oil Shale and the 25 G.P.T. Oil Shale is not by the mining, extraction, processing and beneficiation rendered unfit or significantly lowered in quality for retorting purposes.

(d) The lessee shall have the right and duty to store all 25 G.P.T. Oil Shale which has been mined and all other oil shale which, after mining, has, as a result of processing or beneficiation, become 25 G.P.T. Oil Shale as directed by the Regional Mining Supervisor for its protection and in accordance with Secs. 2(1) and 5 of this lease. Except as otherwise provided herein, or unless otherwise authorized in writing by the Regional Mining Supervisor, the lessee shall, prior to disposition, process or beneficiate any leased deposits in mined material to extract sodium compounds therefrom where that material contains oil shale averaging more than 10 gallons of shale oil per ton of rock mined, but less than 25 gallons per ton, such average to be determined by modified Fischer assays of that material; the aforesaid processing or beneficiation to be performed in such a manner that the lessee separates from the sodium compound material that quantity of contained organic matter necessary to limit the shale oil content, if any, to not more than an average of 10 gallons per ton in the material removed from the leased premises. The lessee shall store or dispose of, as determined and directed by the Regional Mining Supervisor, residue and/or waste materials which have been separated from the leased deposits or products thereof during or as a result of mining, extraction, processing, beneficiation, retorting and other operations conducted under this lease, where the aforesaid storage or disposal is not otherwise provided for or authorized in this Sec. 1(d) or in Sec. 1(e), for the protection or disposal of such materials as appropriate and in accordance with Secs. 2(1) and 5 of this lease. It is understood that the processed 25 G.P.T. Oil Shale or other processed oil shale, and, upon the termination of this lease, any sodium compounds intermingled therewith shall remain the sole property of the lessor and shall be subject to disposition at any time by the lessor as provided in Sec. 3(a)(1) hereof or otherwise.

(e) In the event that retorting or processing of the leased deposits results in the production of any shale oil whatsoever, all such shale oil shall, anything in this lease to the contrary notwithstanding, be and remain the exclusive property of the lessor and shall be disposed of by the lessor or, at lessor's option, lessee shall dispose of such shale oil, if any, at the direction of the Regional Mining Supervisor, given within a reasonable time after its production, on such terms as are just and reasonable and do not require lessee to bear the costs of disposing of such shale oil, it being understood, that, if lessee is required by lessor to store such shale oil, if any, then the costs of such storage shall be initially borne by lessee but such costs shall be credited by lessor against royalties payable under this lease by lessee as such royalties become due and payable thereafter. In furtherance of the rights reserved and retained herein by the lessor, any contract or other agreement entered into by the lessee, or its successors in interest, for the sale, transfer, or disposal of leased deposits or the products thereof shall specifically provide that the purchaser or transferee, or its successors in title, if any, of any leased deposit or the products thereof neither intends to nor shall produce shale oil therefrom and lessee shall be obligated under this lease to make no further sale or transfer of any leased deposit or any products thereof to any purchaser or any of its successors in title of any leased deposit or the products thereof who has violated such contractual provision. Moreover, the lessee shall take whatever action may be necessary to recover for the lessor any shale oil so produced in any significant quantity which is then still in existence or to recover damages which shall be payable to the lessor if any such significant quantities of shale oil have been produced and are no longer in existence.

Sec. 2. The lessee hereby agrees:

(a) **Bond.** To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all of the provisions of the lease, except those provisions compliance with which is made subject to the bond required under subsection 5(e) hereof, and to increase the amount of, or to furnish such other, bond as may be required.

(b) **Rental.** To pay the lessor, annually, in advance, for each acre or part thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents per acre or fraction thereof for the first calendar year; 50 cents per acre for the second, third, fourth, and fifth calendar years, respectively; and $1 per acre for the sixth and each succeeding calendar year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

(c) **Royalty.** To pay the lessor a royalty of 3 percent of the quantity or gross value of the output of the leased deposits at the point of shipment to market for the first ten years of this lease; 4 percent beginning with the eleventh year and for each succeeding year to and including the fifteenth year; and thereafter 5 percent beginning with the sixteenth year and for the remainder of the primary lease term.

Royalties on any of the leased deposits shall be payable monthly in cash or delivered in kind at the option of the lessor. It is expressly understood that the Secretary of the Interior may establish reasonable minimum values for the purpose of computing royalty on any of the leased deposits, due consideration being given to the highest price paid for the part or a majority of the production of like quality products from Wyoming or elsewhere in the same general area, the price received by the lessee, posted prices, and other relevant matters.

When paid in value such royalty on production shall be due and payable monthly on the last day of the calendar month following the calendar month in which produced.

When royalty is to be taken in kind the lessee will be notified 3 months in advance that delivery of royalty products will be required for a stated period not exceeding 12 months. Royalty products shall be delivered in merchantable condition at the point of shipment without cost to the lessor at such time and in such storage facilities provided by the lessee as may reasonably be required by the lessor, provided, that the lessee shall not be required to hold the royalty products in storage for more than 60 days beyond the end of the month in which produced, and provided further, that the lessee shall in no manner be responsible or held liable for the loss or destruction of the royalty products in storage from causes over which the lessee has no control.

It is expressly understood that, notwithstanding any other provision hereof, the lessor reserves the right to readjust the royalties prescribed in this subsection 2(c) as provided for in subsection 3(d) hereof.

(d) **Minimum production.** Beginning with the sixth full calendar year of the lease, except when the Secretary has directed or consented to a suspension of operations under Section 39 of the Act, to mine the leased deposits during the said year to a royalty value of $1 per acre or fraction thereof, and thereafter the royalty value shall increase $1 per acre per year each succeeding year to and including the tenth year to a royalty value of $5 per acre or fraction thereof, and thereafter the royalty value shall be $5 per acre or fraction thereof per year for the remainder of the lease term, or beginning the sixth year, in lieu of any mining to pay minimum royalty of $1 per acre or fraction thereof, and thereafter the minimum royalty shall increase $1 per acre per year each succeeding year to and including the tenth year to a minimum royalty of $5 per acre or fraction thereof, and thereafter the minimum royalty shall be $5 per acre or fraction thereof per year for the remainder of the lease term.

(e) **Payments.** To make rental payments to the Manager of the appropriate Land Office, except that when this lease becomes productive the rentals and royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey with whom all reports concerning the operations under the lease shall be filed. All remittances to the Manager shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) **Plats, reports, maps.** (1) At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and cots. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each month a report covering such month, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such propose, showing the amount of leased deposits mined during the month, the character and quality thereof, amount of its products and by-products disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with regulations in 30 CFR Part 231. (2) To prepare and furnish at such times and in such form as the Regional Mining Supervisor may prescribe, maps, photographs, reports, statements and other documents in accordance with the regulations in 43 CFR Part 23 to the same extent as if the operations under this lease were surface mining.

(g) **Weights.** To determine accurately the weight or quantity and quality of all leased deposits mined and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) **Inspection and investigation.** To permit at all reasonable times (1) inspection or investigation by any duly authorized officer of the Department of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) **Assignment.** To file for approval in the appropriate Land Office, within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect on the first day of the month following approval by the Bureau of Land Management, or, if the assignee requests, on the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(k) **Lands disposed of with leased deposits reserved to the United States.** If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the leased deposits therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such deposits.

(l) **Operations, mining and reclamation of lands, wages, freedom of purchase.** To comply with the operating regulations (30 CFR Part 231), to exercise reasonable diligence, skill, and care in the operation of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and of waste or damage to any water or mineral deposits; to comply, to the same extent as if the operations under this lease were surface mining, with the applicable provisions of the surface exploration, mining and reclamation of lands regulations (43 CFR Part 23) to avoid, minimize, or correct damage to the environment—land, water and air—and to avoid, minimize, or correct hazards to the public health and safety; to pay all wages due miners and employees both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding 8 hours in any one day for underground workers, except in cases of emergency; to employ no boy under the age of 16 and no girl or woman, without regard to age, in any mine below the surface, unless the laws of the State otherwise provide, in which case the State laws control.

(n) **Overriding royalties.** Not to create, by assignment or otherwise, an overriding royalty in excess of 1 percent of the gross value of the output at the point of shipment to market unless the owner of that interest files his agreement in writing that such interest is subject to reduction or suspension to a total of not less than 1 percent of such gross value, whenever, in the interest of conservation, it appears necessary to do so in order to (1) prevent premature abandonment or (2) make possible the economic mining of marginal or low-grade deposits on the leased lands or any part thereof.

(o) **Delivery of premises in case of forfeiture.** In case of forfeiture of this lease to deliver up to the lessor in good order and condition, in accordance with the applicable regulations, and subject to the provisions of Sec. 6 hereof, the land leased, including permanent improvements and other property, whether fixtures or personalty, and all underground timbering and such other supports and structures as are necessary for the preservation of any mines, other underground development works, or deposits.

(p) **Extraction by solution.** Where the minerals are taken from the earth in solution, with the express consent of the lessor which must be first obtained, the location within a producing formation of an entry, well, or opening for extraction shall not be within 500 feet of the boundary line of leased lands without the permission of or unless directed by the lessor, nor shall induced fracturing extend to less than 100 feet from the boundary line.

(q) **Operation in the exploration for and development and production of the leased deposits and concurrent or future operations in oil shale deposits, or other leasable deposits.**

(1) Not to conduct exploration or mining operations that, in the opinion of the Regional Mining Supervisor, (A) would be hazardous to the concurrent or future production of mineral deposits under existing leases issued pursuant to the Act for the same tracts of land, or of oil shale not located in the Saline Zone or the 25 G.P.T. Oil Shale in the Saline Zone in the same tracts of land, (B) would interfere with the orderly concurrent or future development and production of mineral deposits under existing leases issued pursuant to the Act for the same tracts of land, or of oil shale not located in the Saline Zone or 25 G.P.T. Oil Shale in the Saline Zone in the same tracts of land, unless the Secretary determines that the interest of the United States would be served thereby, or (C) would result in undue waste of mineral deposits subject to existing leases issued pursuant to the Act for the same tracts of land, or of oil shale in the same tracts of land.

Operations conducted in conformity with the provisions of subsections 1(c), (d) and (e) of this lease shall not be deemed to cause undue waste of oil shale.

(2) To make available for inspection by the holder of any oil shale lease issued for the same tracts of land, or any zone thereof, maps of mine workings and surface installations and records of core analyses required to be filed pursuant to the applicable operating regulations insofar as such maps and records are pertinent to the development and protection of oil shale deposits.

Sec. 3. The lessor expressly reserves the following rights, powers, and authority:

(a) **Easements; rights-of-way.**

(1) Upon such terms as it may determine to be just, the right to permit for joint or several use such easements or rights-of-way, including easements in tunnels, upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the government, its lessees or permittees, and for other public purposes.

The rights reserved hereunder expressly include the right to issue oil shale leases for all or any part of the tracts of land subject hereto, including the Saline Zone in or under the said tracts of land, and the right to issue sodium leases for all or any part of the tracts of land subject hereto, excluding the Saline Zone in or under the said tracts of land, due regard being given to the rights of lessee to the leased deposits.

(2) The right to conduct geological and other investigations which do not interfere with or endanger operations under this lease.

(b) **Disposition of surface.**

The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the leased deposits therein, or to dispose of any surface resource in such lands which will not unreasonably interfere with operations under this lease.

(d) **Renewal terms.**

The right reasonably to fix rentals and royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 10-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 10-year period, he will be deemed to have agreed to such terms and to the renewal of the lease.

(e) **Waiver of conditions.**

The right to waive any breach of the conditions contained herein, except such conditions as are required by the Act, as amended, but any such waiver shall extend only to the particular breach as waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. Relinquishment of lease. Upon a satisfactory showing of compliance with the applicable regulations and that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment must be filed, in duplicate, in the proper Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety, in accordance with the applicable regulations and the terms and conditions hereof, (1) to make payment of all accrued rentals and royalties; (2) to provide for the preservation of any mines, underground development works, other permanent improvements or other property, whether fixtures or personalty, on the leased land; (3) to provide for the reclamation of lands and waters affected by exploration or mining operations under this lease; and (4) to comply with all requirements of Section 5 of this lease.

Sec. 5. Protection of the environment, nonmineral resources, and improvements, and reclamation of lands and waters. The lessee agrees:

(a) To the same extent as if the operations under this lease were surface mining, to meet all requirements formulated in accordance with the regulations in 43 CFR Part 23, for the preservation and protection of the environment—land, water, and air—and for the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and for the reclamation of lands and waters affected by exploration or mining operations.

(b) In addition to meeting the requirements specified in paragraph (a) hereof, to conduct exploration or mining operations in compliance with all applicable Federal, State and local water pollution control, water quality, air pollution control, and air quality standards.

(c) To comply with any exploration or mining plan, or amended, supplemental, or partial plan, approved in accordance with the regulations in 43 CFR Part 23 (to the same extent as if operations under this lease were surface mining), the requirements of paragraph (b) hereof, and other terms and conditions of this lease, and to take such steps as may be specified in any such environment and for the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and for the reclamation of lands and waters affected by exploration or mining operations.

(d) To comply with the requirements for cessation or abandonment of operations under any exploration or mining plan, or amended, supplemental or partial plan, approved in accordance with the regulations in 43 CFR Part 23 (to the same extent as if operations under this lease were surface mining), the requirements of paragraph (b) hereof, and other terms and conditions of this lease, and to carry out and complete operations, including all reclamation requirements, in accordance with any such plan.

(e) Upon approval of an exploration plan or mining plan, to file with the lessor and maintain, in addition to the bond required under subsection 2(a) hereof, a bond in an amount of not less than $500 per acre of land estimated to be affected during the first 3-year period of exploration or mining operations, and thereafter during each succeeding 3-year period of exploration or mining operations, or in such amount as may be established at the time of approval of any exploration or mining plan, including amended, supplemental, or partial plans, whichever is greater, but in any event in an amount of not less than $2,000, which bond shall be conditioned upon the faithful compliance with the regulations in 43 CFR Part 23 (to the same extent as if operations under this lease were surface mining), particularly Sec. 23.9, the terms and conditions of this Sec. 5, and any approved exploration or mining plan, or approved amended, supplemental, or partial plan, as the same relate to the preservation and protection of the environment—land, water, and air—and the protection and conservation of nonmineral resources during the conduct of exploration or mining operations, and to the reclamation of lands and waters affected by exploration or mining operations.

The amount of the bond may be increased or decreased upon approval of an amended, supplemental, or partial mining plan which includes an increase or decrease in the estimated number of acres to be affected during the period of exploration or mining operations covered by the plan, but in no event shall the amount become less than $500 per acre of land estimated to be affected, nor less than $2,000 in total amount, during the period of operations covered by the plan. The bond may be released as to leased lands affected by exploration or mining operations during the period covered by an approved exploration or mining plan, or approved amended, supplemental, or partial plan, at such time as, and to the extent that it is determined by the lessor that such lands meet the reclamation requirements of the approved exploration or mining plan and that operations have been carried out and completed with respect to these lands in accordance with the approved plan.

(f) To take such reasonable steps and to conduct operations in such manner as may be needed to prevent operations from unnecessarily: (1) damaging any forage and timber growth on the leased lands, or on Federal or non-Federal lands in the vicinity; (2) damaging crops, including forage, timber, or improvements of a surface owner; or (3) damaging improvements whether owned by the United States or by its permittees or lessees. The lessor may prescribe the steps to be taken and the restoration to be made with respect to the leased lands and improvements thereon, whether or not owned by the United States, in the event of the occurrence of damage described in this paragraph (f).

Sec. 6. Removal of property on termination of lease. Upon termination of this lease, by surrender or forfeiture, the lessor, his agent, licensee, or other lessee, shall have the exclusive right, at the lessor's election, to purchase at any time within 6 months thereafter, at the appraised value thereof, any or all structures, equipment, machinery, tools, appliances, and materials, whether fixtures or personalty, placed by the lessee in or on the land leased hereunder, other than all underground timbering and such other supports and structures as are necessary for the preservation of any mines or other underground development works, which shall be and remain a part of the realty without further consideration or compensation; the purchase price to be paid for such structures, equipment, machinery, tools, appliances, and material shall be fixed by appraisal of three disinterested and competent persons (one to be designated by each party thereto and the third by the two so designated), and the valuation of the three or a majority of them shall be conclusive; pending such election to purchase within said period of 6 months, none of those structures of other property shall be moved from its normal position.

At any time within a period of 90 days after election by the lessor not to purchase or upon expiration of said period of 6 months without election by the lessor, the lessee shall have the privilege of removing from the premises said structures and other property except said timbering and other supports and the structures as are necessary for the preservation of any mines or other underground development works as aforesaid. Any structures, machinery, equipment, tools, appliances, and materials, subject to removal by the lessee as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions or other good and sufficient reason, at the election of the lessor, but the lessee shall remove any or all of such property on expiration of said 90-day period when so directed by the lessor.

Sec. 7. Remedies in case of default. If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or make default in the performance or observance of any of the provisions of this lease and such default shall continue for a period of 30 days, or such other period as may be specified under applicable regulations, after service of written notice thereof by the lessor, the lessor may suspend operations where authorized by the applicable regulations until such time as any required action is taken to correct noncompliance, or the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Sec. 31 of the Mineral Leasing Act, and for forfeiture of any performance bond required by the applicable regulations. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee.

Sec. 8. Heirs and successors in interest. Each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 11. There are attached hereto and specifically incorporated in and made a part of this lease stipulations of the general requirements formulated pursuant to the regulations in Title 43 CFR Part 23, particularly Sec. 23.5, which have been made known in writing to and accepted by the undersigned lessee and which the said lessee must meet for the protection of nonmineral resources during the conduct of exploration or mining operations and for the reclamation of lands or waters affected by exploration or mining operations.

Stipulations of General Requirements Formulated Pursuant to Title 43 CFR Sec. 23.5

1. All existing improvements used by the lessee such as fences, gates, cattle guards, roads, trails, culverts, pipelines, bridges, public land survey monuments and water development and control structures shall be maintained in serviceable condition to the degree practicable. Damaged or destroyed improvements shall be replaced, restored or appropriately compensated for. When it becomes absolutely necessary, and only upon prior approval of the Bureau of Land Management through the Regional Mining Supervisor, the lessee may disturb a public land survey corner marker or monument. However, the lessee shall bear all costs of any surveys required to preserve the true point of the marker.
2. Construction of the leased premises of housing and other facilities related to community or urban development shall be kept to a minimum and shall be authorized only upon the written approval of the District Manager.
3. The lessee agrees to remove or otherwise dispose of housing and service buildings or any other such facilities to the satisfaction of the Regional Mining Supervisor at the termination of the lease.
4. All operations under this lease shall be designed and performed so as to make use of the natural topography to achieve harmony with the landscape to the degree practicable.
5. Drill holes, excavations and improvements shall be conditioned at all times to prevent injury to persons, livestock and wildlife.
6. Where compatible with operations conducted by the lessee, the lease area shall be available for other public surface uses including livestock grazing, hunting, fishing, camping, hiking, and picnicking.
7. Grazing or resting livestock shall not be unnecessarily disturbed.
8. Access to the leased premises upon, through, or across private or State lands is not guaranteed by the Government. The lessee has the responsibility for securing access rights-of-way in such circumstances.
9. Where practicable existing roads shall be used. Activities employing wheel or tract vehicles shall be conducted in such a manner as to minimize surface damage. If damage occurs, the road shall be restored to original or near original condition as soon as possible.
10. All new roads and trails shall be constructed and maintained in such a manner as to control and minimize channeling or other erosion. Roads and trails shall be constructed only at locations approved in advance by the Regional Mining Supervisor after consultation with the District Manager.
11. Off-road vehicular traffic in connection with lease operations, authorized construction activities or otherwise shall be permitted only when and as authorized in advance by the Regional Mining Supervisor after consultation with the District Manager, or in emergency situations.
12. All operations must be conducted so as not to adversely change the character or cause pollution of streams, lakes, ponds, water holes, seeps and marshes or cause damage to fish and wildlife resources. Contaminants or pollutants shall be controlled and not be allowed to enter streams, springs, stock waters or groundwaters. No water shall be used from stock ponds or springs without the written consent of the owner.
13. The clearing of timber, stumps and snags shall be kept to a minimum, and due care shall be used to avoid scarring or removal of ground vegetative cover in areas not involved in the mining operations.
14. All disturbed areas must be returned as nearly as practicable to their original condition and as soon as practicable, as may be more specifically provided for

in any exploration or mining plan approved in accordance with Secs. 5(c) and (d) of the lease and the applicable regulations.

15. Due to the importance of the winter deer range and the deer migration route to crucial winter range, habitat disturbance should be kept to as small an area as possible. Pinyon-juniper stands that are necessary for wildlife cover should be avoided. Stockpiling of waste material shall be in as small an area as possible.

16. When American antiquities or other objects of historic or scientific interest including but not limited to historic or prehistoric ruins, vertebrate fossils, or artifacts are discovered in the course of operations or activities conducted under this lease, the item(s) or condition(s) will be left intact and immediately brought to the attention of the District Manager through the Regional Mining Supervisor.

17. If the Bureau of Land Management archaeologist or a Bureau of Land Management approved archaeologist determines that the areas to be used for development contain potential archaeological values, the lessee will engage a recognized authority on archaeology acceptable to the Bureau of Land Management to survey and salvage in advance of mining. The responsibility for this survey and salvage, including payment of any costs, shall be upon the lessee.

18. Ore, by-products, or waste material shall be stored or stockpiled in such a manner as to prevent the production of agents or pollutants that may harm or kill vegetative cover.

19. Lease operations shall be conducted in accordance with all applicable Federal laws, regulations and standards, to the extent consistent with the Mineral Leasing Act of 1920, as amended (30 U.S.C. secs. 181-263), hereinafter referred to as the Act, and all applicable State laws, regulations and standards, to the extent consistent with the Act and other Federal laws.

20. The lessee shall, to the extent consistent with the Act and other Federal laws, comply with the Rio Blanco County zoning resolutions, subdivision regulations, and mobile home regulations, and shall furnish three (3) copies of any written approval required thereunder to the Regional Mining Supervisor for transmittal to the District Manager.

21. Prior to commencing any on-the-ground activities, the lessee shall submit to the Regional Mining Supervisor five (5) copies of a mining plan which sets forth the operational steps to be followed in complying with each surface management stipulation including those items listed in Section 5 of Form 3520-3. Proposed access routes and operational sites will be illustrated on a topographic map, 7.5 minute quadrangle, or aerial photograph when available. This plan shall be approved by the Regional Mining Supervisor after consultation with the District Manager in advance of any and all operations.

22. A copy of these stipulations and any current, approved, exploration and/or mining plan shall be kept at the operating site and be available for inspection at all times.

6.6 APPENDIX F - ANALYSIS OF THE PROPOSED ACTION AND THE UNDERGROUND INJECTION CONTROL PROGRAM ADMINISTERED BY THE ENVIRONMENTAL PROTECTION AGENCY

6.6 Appendix F - Analysis of the Proposed Action and the Underground Injection Control Program Administered by the Environmental Protection Agency

(This appendix is included as prepared and presented by EPA at their request and for their convenience.)

Background

Under provisions of the Safe Drinking Water Act, the Denver Regional Office of the EPA must assure protection of underground sources of drinking water (USDW) for activities involving the injection of fluids into the ground. (See 40 CFR Parts 100 to 149, July 1, 1984.) The Underground Injection Control (UIC) regulations define five separate classes of injection wells including: Class I—deep wells disposing of hazardous waste or other industrial and municipal wastes; Class II—oil and gas-related injection wells; Class III—mineral extraction injection wells; Class IV—shallow hazardous waste or radioactive waste wells; (Class IV wells are currently banned), and Class V—any other type of injection well including those using experimental technology. EPA has delegated the Class II portion of this program to the Colorado Oil and Gas Conservation Commission but has retained jurisdiction over Class I, III, IV, and V injection wells.

The UIC regulations define a USDW as any aquifer which supplies a public water system, or contains sufficient quantity of ground water to supply a public water system and which contains less than 10,000 ppm total dissolved solids (TDS). Once a UIC program becomes effective (June 25, 1984, for Colorado), injection operations must be authorized by EPA which includes requirements for construction, monitoring, testing, reporting, operating, and ultimately for plugging and abandonment of injection wells.

One element of the UIC program deals with aquifer exemptions. The intent of exempting an aquifer is to allow injection to occur into a formation which would otherwise be considered a USDW, that is containing water with less than 10,000 mg/l TDS. Once an aquifer has been exempted, it need no longer be considered as a viable or potential source of drinking water and therefore protective requirements are not imposed specifically for the exempted aquifer. For most injection well actions, aquifer exemptions are limited to the injection zone itself. However, a provision of the regulations exists whereby an aquifer which overlies a Class III mine operation may be exempted if it is subject to subsidence or catastrophic collapse such that the aquifer would be seriously endangered or totally destroyed. Such endangerment of the aquifer would mean the mining activity would not be in compliance with the UIC requirements. Since the proposed nahcolite mine is located below a USDW, consideration of whether or not these overlying aquifers should be protected or exempted under the UIC program is a major issue.

The Wolf Ridge nahcolite bulk sampling program as described in this EIS took place prior to the effective date (June 25, 1984) of the UIC program in Colorado. Subsequently, EPA determined that injection for the purposes of the proposed pilot plant project could take place under authorization by rule of a Class V well. This authorization expires on July 31, 1986. Classification of the pilot project as a Class V well was based on representations made by the corporation that the technology involved in constructing and operating the injection wells was experimental. The authorization by rule is contingent upon the operator submitting well completion reports on the bulk sampling wells, providing advance notice prior to drilling and providing the proposed and final well specifications regarding all aspects of the pilot project.

Purpose and Need for this Appendix

This Appendix is intended to alert the public and decision makers of the available mechanisms by which the proposed plan will assure compliance with the UIC program. This brief appendix does not thoroughly analyze the detailed technical information in the proposed mine proposal to determine if changes are required in the mine plan to assure compliance with the UIC provisions.

Current UIC permit status—Bulk Sampling and Pilot Operation

Wolf Ridge holds a Class V Authorization for Underground Injection by Rule for operating a pilot operation which expires July 31, 1986. The pilot project has not yet commenced and the operator has requested that EPA approve an extension of the authorization by rule. Currently under consideration by EPA is: 1) whether to extend the Class V authorization by rule for the pilot plant operations which are described in this EIS, 2) whether to approve these facilities with additional construction, reporting, monitoring, and/or abandonment requirements or 3) whether to include the Pilot Project with the full scale project in a Class III Authorization by Permit under the UIC requirements. A Class III permit is for operations involving the injection of fluids for the purposes of mineral extraction (i.e. salts or potash) using proven technology. UIC requirements specify that an authorization by Class III permit shall be issued defining the monitoring, well completion, operating procedures, mechanical integrity procedures, and plugging procedure upon abandonment. Should EPA determine that the pilot operation is still an experimental phase, it could extend authorization by rule for an additional time to allow Wolf Ridge to conduct its pilot operation as planned or as amended by EPA.

Should EPA determine that the pilot operation is not experimental, then a Class III permit would be required. At this point, EPA is inclined to continue rule authorization under the Class V definition based upon the fact that control of the mined-out cavern and subsequent stability has not yet been proven using the technology proposed by Wolf Ridge. EPA could allow such authorization for either one, two or three cavities prior to concluding that the experimental technology has been demonstrated. However, based upon representations by the corporation that one cavity will suffice to demonstrate that the technology is proven, EPA intends to extend this authorization for just one cavity. EPA may still impose additional well completion, monitoring and reporting requirements as a condition of the authorization by rule. The public is welcome to comment on this EIS on any aspect of this decision before EPA.

Current UIC permit status—Commercial Operations

According to company officials, an application for a Class III UIC permit will be submitted to the regional office of EPA by August or September, 1986. EPA expects to take 6 to 8 months to process a draft Class III UIC permit. Opportunity for public comment and a hearing will be provided under the regulations. During preparation of this UIC permit, EPA will evaluate the application for completeness; approve or amend aspects of the plan regarding the method of well construction, the means and methods of monitoring to assure the mechanical soundness of the wells; and/or approve or amend the means and methods of plugging and abandoning the injection wells. Under provision of the UIC program, the Wolf Ridge Corporation could also apply at that time to exempt the aquifers overlying the mine zone from consideration as USDW's. An application for an exemption could lengthen the time needed to process the permit by at least six months.

Significant Issues identified by EPA

Among the many complex technical issues under consideration by EPA, perhaps the most critical are the requirements for well casing and cementing, well abandonment, and the aquifer exemption process. A discussion of the foreseeable alternatives is presented below.

A) An aquifer exemption may be issued if justified by site-specific conditions by EPA for aquifers which overlie a Class III mine project. The criteria used for an exemption of aquifers overlying a Class II mine zone is the potential for catastrophic collapse and subsidence which will cause significant endangerment or total destruction of the aquifer. Should the operator claim that subsidence will occur and therefore seek an aquifer exemption for either the upper or lower aquifer unit, EPA would consider the application as a major action and publish the proposal in the FEDERAL REGISTER and provide opportunity for public comment. The review and approval would be made by the Administrator of EPA. A functional equivalent EIS would be necessary which would examine mining alternatives which could minimize subsidence sufficiently to avoid endangerment of the aquifer. Should either of the aquifers overlying the mine zone be exempted under EPA's exemption procedures, the casing and cementing requirements might be lessened and mining might proceed without complete protection afforded to the exempted aquifer. EPA would still need to issue a Class III permit with certain operating, completion, testing, monitoring and reporting requirements.

   The lease agreement issued by BLM for the operation of the pilot plant stipulates that the recovery of nahcolite cannot include the undue waste of the oil shale in the Mahogany Zone and any zone containing oil shale with more than 25 gallons per ton. Under this lease stipulation BLM intends to prohibit against such catastrophic collapse of the oil shale resources so that oil shale might be recovered in the future. Given that condition by BLM, it appears that an aquifer exemption would not be warranted because catastrophic subsidence is not allowed to occur. However, the mine process and subsequent subsidence could disrupt the lower aquifer which is below the Mahogany Zone's B-Groove. If so, this could be the basis of an aquifer exemption not otherwise inconsistent with BLM's lease stipulation.

B) A second approach that the operator may seek in obtaining an aquifer exemption is to provide a demonstration that the public use for drinking water of either the upper or lower aquifer is not reasonably or economically practical. The UIC regulations provide for granting an exemption on this basis, however, this criteria has been interpreted by EPA to exclude aquifers above the injection zone. A recent decision by EPA Denver denying an aquifer exemption request maintained that granting aquifer exemptions on the basis of economical practicality is limited to injections into a USDW. Approximately 30 aquifers exempted to date by the Denver Regional Office of EPA under the criteria of not being economically practical have been for injection into, not below, the USDW. All these aquifer exemptions were related to oil and gas recovery.

Neither of the aquifers overlying the mine zone are known to serve as a drinking water source in the area. The regional area currently depends upon stream flow in the White River to supply the Towns of Meeker and Rangely. Public water supplies in the future could still be obtained from the White River since it is likely the most practical or least cost water supply in the region. In addition, the EIS presents data that appears to show the mineral content of both the upper and lower unit to be high in fluoride content exceeding the Interim Primary Drinking Water Standards. If so, treatment would have to be provided to render if fit for human consumption.

C) There is also an equal possibility that a request for an aquifer exemption will not be made, or if it is requested it could be denied by EPA if no catastrophic subsidence would occur affecting the USDW or if EPA determined that the overlying aquifers above a mine extraction well may not be granted an exemption based upon the economics or practicality of use as a public water supply. EPA would then be obligated to decide issues relating to the technical requirements of a Class III permit which protects the USDW. Among the important issues under this consideration if there is no approved aquifer exemption are:

1) Whether Wolf Ridge's plan to cement off 100 feet above the production zone is adequate to protect the aquifers, or if BLM's requirement to cement up to the A groove above the Mahogany Zone is more appropriate or whether something in between would be acceptable. A related matter concerns whether the corporation's plan for final plugging and abandonment is adequate.

As described in the EIS, the corporation plans to provide a 100-foot long cement plug above the production zone then pull the production casing and plug the abandoned well hole with a chemically-gelled mud. BLM has issued a lease stipulation for the pilot plant wells and intends to further mitigate the commercial phase of the proposal by imposing a lease stipulation that requires the company to cement the annulus between the well bore hole and the well casing up to the A-groove above the Mahogany Zone. This is another 600 feet higher than proposed by the company. Under the corporate plans, the production casing would be cut off above the 100-foot long cemented annulus, the casing then filled with cement, and the remainder of the production tubing removed for re-use in the next well. The open hole would be filled with an abandonment mud or gel. This could still be done under BLM's required stipulation but 600 feet higher than that proposed by the Wolf Ridge Corporation. According to company officials, they plan to appeal BLM's application of this lease stipulation since they believe the additional cement unnecessary to assure protection of the aquifer and because they assert that the gel will provide better protection than brittle cement in the case of subsidence. EPA must determine which method of well completion and abandonment is necessary to assure protection of the USDW or if additional measures would be required to assure this protection. The need for this or other additional construction and plugging requirements must be determined by EPA for both the pilot plant operations and the commercial phase of the operations based on data supplied by the applicant. Under the EIS process EPA is seeking public comment on this aspect of the proposal.

2) Whether spacing of the cavities is adequate to prevent subsidence from interrupting the lower aquifer unit.

The lower aquifer unit could be disrupted by subsidence as a result of collapse into the mined-out nahcolite cavities. According to corporation reports, maintaining the 20-foot pillar width between the cavities will provide adequate support to minimize this subsidence. The company also claims that the saturated brine remaining in the cavity and the residual insoluble material left on the edge of the cavity will not allow for post-mining dissolution. This is based on experience at salt solution mines in other regions of the country. EPA must determine if this plan will be adequate to protect the USDW in the upper and lower aquifer from degradation or if a revised mine plan is necessary to assure such protection.

3) What additional showings must be made by the company to demonstrate protection of USDW's, including monitoring, testing and reporting requirements. Among the issues of concern is the need to supply further information on th nature of ground water flow beneath the lease area.

There is a lack of technical agreement among geologists familiar with the Piceance Basin whether or not there is a pressure gradient in the lower aquifer unit sufficient to force ground water upwards. If so, this would have an effect on the type of controls necessary to isolate the naturally saline waters in the lower part of the unit and the saturated brines in the production cavities which may be separated from the upper unit by the Mahogany Zone and any possible discharge to the surface. If no gradient exists towards the surface, then the salt-saturated brines in the lower unit may stay there and not effect the upper aquifer since no force would move these heavier, denser waters to the surface. Several reports show that the lower unit is pressured and capable of moving waters to the upper unit should the relatively impermeable Mahogany Zone be disrupted or a failed well casing allow upward flow. Additional on-site verifiable data may be needed to establish which of these conditions exist as this site.

6.6 Appendix F - Analysis of the Proposed Action and the Underground Injection Control Program Administered by the Environmental Protection Agency

EPA would appreciate public comment on the need to protect these aquifers, the ability of the local communities in the area to be assured of adequate alternative future water supplies, if there is a practical economical means of obtaining these ground waters for a public water supply including the possible need to treat these waters to meet drinking water criteria or any other pertinent information regarding the need to protect these ground water resources.

7. GLOSSARY

7. GLOSSARY

ACRE-FOOT. The volume of water (43,560 cubic feet) required to cover 1 acre to a depth of 1 foot.

ACTIVE NEST. An active raptor nest is one which: (a) is known to have been used by nesting raptors in at least one of the three preceeding years, or (b) is in such condition that prior use by raptors can be verified, and little or no repair will be required for its subsequent use for nesting.

AIR BASINS. These are the areas in which weak dispersion conditions result from the effects of obstructions on the normal wind flow pattern. These obstructions are elevated topographic features, such as mountain ranges or canyon walls.

ALKALINE. An adjective describing soils or water containing a soluble salt or mixture of soluble salts in sufficient quantity to be detrimental to agriculture; having a pH of more than 7.

ALLOTMENT. An area of land where one or more operators graze their livestock. It generally consists of public lands but may include parcels of private or state owned lands. The number of livestock and period of use are stipulated for each allotment. An allotment may consist of several pastures or only one pasture.

ALLUVIAL SOIL. A soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recently deposited materials.

ALLUVIAL VALLEY FLOORS. The floors of alluvial valleys that are covered with unconsolidated stream-laid deposits. The water in the streams in these valleys is sufficient for subirrigation or for flood irrigation of crops.

ALLUVIUM. Clay, silt, sand, gravel, or other rock materials transported by flowing water. Deposited in comparatively recent geologic time as sorted or semisorted sediment in river beds, estuaries, floodplains, lakes, and shores, and in fans at the base of mountain slopes.

AMBIENT AIR QUALITY. The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

ANIMAL UNIT MONTH (AUM). The amount of forage necessary for the subsistence of one cow or its equivalent for a period of one month.

ANION. Negatively charged ions.

ANISOTROPIC. Exhibiting properties with different values when measured along axes in different directions.

AQUIFER. A water bearing bed or stratum of permeable rock, sand, or gravel capable of yielding considerable quantities of water.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN (ACEC). Areas within the public lands where special management attention is required (when such areas are developed or used or where no development is required) to protect and prevent irreparable damage to important historical, cultural or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and ensure safety from natural hazards.

These are not necessarily areas in which no development can occur. Limited development, if wisely planned or properly managed, can take place in these areas without unduly risking life or safety or causing permanent damage to historical, cultural or scenic values or natural system processes.

AVAILABLE WATER HOLDING CAPACITY. The capacity of soils to hold water available for use by most plants.

BAGHOUSE. A pollution control device for removing particulate matter from air by filtering it through fabric tubes.

BEDROCK. The more or less solid rock in place either on or beneath the surface of the earth.

BEST AVAILABLE CONTROL TECHNOLOGY (BACT). A regulatory rating system for the control technologies applied to a source subject to the Prevention of Significant Deterioration Regulations. BACT is determined on a case-by-case basis by the regulating agency (EPA or the state). It is defined as that technology which provides the highest degree of pollution control, while taking into account the suitability of application as well as cost factors.

BIOLOGICAL ASSESSMENT. A procedural step in the interagency consultation process under Section 7 of the Endangered Species Act where BLM submits a written summary of potential project impacts to threatened or endangered species to the USFWS for their evaluation.

BOREHOLE. A hole made with a drill auger or other tools for exploring strata in search of minerals, for water supply, for blasting purposes, for proving the position of old workings, faults, and for releasing accumulations of gas or water.

BRECCIA. A fragmental rock with angular compontents. Any rock formation essentially composed of uncemented, or loosely consolidated, small, angularly shaped fragments.

BULKING. The increase in volume of a material as a result of manipulation (i.e., subsidence).

CANDIDATE SPECIES. Candidate species are any species not yet officially listed but which are undergoing a status review or are proposed for listing according to *Federal Register* notices published by the Secretary of the Interior or the Secretary of Commerce. Includes three categories:

CATEGORY 1 - Taxa for which the Fish and Wildlife Service (FWS) presently has sufficient information to support the biological appropriateness of their being listed as Endangered or Threatened species.

CATEGORY 2 - Taxa for which information now in the possession of the FWS indicates the probable appropriateness of listing as Endangered or Threatened, but for which sufficient information is not presently available to biologically support a proposed rule.

CATEGORY 3 - Taxa no longer being considered for listing as Endangered or Threatened. Such Taxa are included in one of three subcategories.

CATEGORY 3A - Taxa for which the FWS has persuasive evidence of extinction.

CATEGORY 3B - Taxa for which the names, based on current taxonomic understanding, do not represent taxa meeting the Endangered Species Act (16 U.S.C. 1531-1543; 87 Stat. 884), definition of "species."

CATEGORY 3C - Taxa that have proven to be more abundant or widespread than was previously believed and/or those taxa which are not subject to any identifiable threat at the present.

CATION. Positively charged ions.

CHANNERY. Channery indicates the soil surface has between 15 and 35 percent of volume of gravel or cobble sized rock fragments (channers) that are much smaller in one dimension than in the other two dimensions. A channer is a small flagstone.

CLIMATE. The statistical collection of an area's weather conditions during a relatively long interval of time (usually several decades).

COLLUVIUM. Loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits.

COMMERCIAL WOODLAND. A pinyon-juniper stand that must: (1) have volumes of timber, preferably pinyon, adequate for economic harvest, (2) be located on slopes less than 25 to 30 percent, and (3) be in close proximity to existing roads.

COMPOSITION. The proportions of various plant species in relation to the total in a given area.

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CRITICAL WINTER RANGE. Refers to the range or habitat that supports the base population of a species during a severe winter. Animals are usually forced onto this limited range because of surrounding snow depth. Based on a average five winters out of 10.

CYCLONE SEPARATOR. A devise which separates particulate matter from air by centrifugal action.

DAWSONITE. A basic carbonate of aluminum and sodium, $Na_3Al(CO_3)2Al(OH)_3$ occurring in thin incrustations of white radiating bladed crystals.

DELTA. The low, nearly flat alluvial tract of land deposited at or near the mouth of a river, commonly of triangular or fan shaped configuration.

DELTAIC. Pertaining to or characterized by a delta.

DECIBEL (dB). A unit of measurement on a logarithmic scale that describes the magnitude of a particular quantity of sound pressure or power with respect to a standard reference value.

DISSEMINATED. Dispersed throughout.

DISSOLUTION. The act or process of dissolving.

DISPERSION POTENTIAL. The ability of the atmosphere to dilute or disperse air pollutants, as determined by normal ventilation values. A high dispersion potential results from high ventilation values, which can be caused by high transport wind speeds, high mixing heights, or high values of both.

DIURNAL. Pertains to actions that are completed over a day and night cycle.

EDGE EFFECT. The influence of a plant community on the successional development of an adjoining area. The degree of influence is related to the amount of contact area (edge) in common. Successional development is enhanced by invasion, establishment, and multiplication of plant species.

ELECTRICAL CONDUCTIVITY. A measure of total salt content.

ELECTROSTATIC PRECIPITATOR. A system for removing particulate matter from air by subjecting the air stream to charges of static electricity.

EMISSION FACTOR. An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

ENDANGERED SPECIES. Any species that is in danger of extinction throughout all or a significant portion of its range.

ENDEMIC SPECIES. A species whose natural occurrence is confined to a certain region and whose distribution is relatively limited.

EPHEMERAL STREAM. A stream that flows for less than 30 consecutive days, which flows only in direct response to precipitation in the immediate watershed, and which has a channel bottom that is always above the local water table.

EROSION. The group of processes whereby earthy or rock material is worn away, loosened or dissolved, and removed from any part of the earth's surface. It includes the processes of weathering, solution, corrosion, and transportation.

EVAPOTRANSPIRATION. The combined loss of water from a given area during a specific period of time by evaporation from the soil or water surface and by transpiration from plants.

EXTIRPATION. Complete destruction or extinction.

FACIES. A rock or group of rocks that differs from comparable rocks (as in composition, age, or fossil content).

FLUVIAL. Sedimentary deposits produced by the action of a stream or river; a deposit consisting of material transported by, suspended in or laid down by a river or stream.

FLY ASH. Finely divided noncombustible material from the precipitators near flues of power generators using pulverized coal.

FORMATION. Any igneous, sedimentary, or metamorphic rock represented as a unit.

FRACTURING. The process of increasing number of fractures and/ or permeability of strata due to subsidence of strata.

GROUNDWATER. That part of subsurface water that completely saturates the rocks and is under hydrostatic pressure.

HABITAT. A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover and living space.

HALITE. Impure common salt, NaCl (sodium-choride); cubic crystals. Occurs widely disseminated or in extensive beds and irregular masses, and interstratified with rocks of other types as a true sedimentary rock.

HERBACEOUS. Green plants with leaflike appearance or texture, not including shrubs, trees, mosses, or lichens.

HERBAGE. Usually used in the same sense as forage, except that it may include material not acceptable to grazing or browsing animals.

HIGH RESISTIVITY ZONE. See SALINE ZONE.

HORIZONTAL GRADIENT. Physically severe or stormy weather.

HYDRAULIC HEAD. The height of a fluid column, usually considered as water, which maintains a pressure on a surface, the amount of pressure being directly proportional to the depth of the fluid standing above the point at which pressure is taken.

INDIRECT IMPACTS. Impacts caused by something which, itself, is a result of something else. In economics, indirect impacts are caused by growth in trade and service activities which, themselves, result from a primary source of growth such as mining.

INTERVALS. The vertical distance between strata or units of reference.

INVERSIONS. A reversal of the normal atmospheric temperature gradient.

ION. An electrically charged particle. In the soil, it refers to an element or combination of elements.

KEROGEN. The organic, oil-yielding material present in oil shale. Kerogen is not a definite compound but a complex mixture varying from one shale to another. When heated to above 900°F, kerogen decomposes to yield a liquid oil, light gases, and a solid residue.

LEACHING. The removal of materials in solution from the soil.

MANTLE. The soil or other unconsolidated rock material more commonly referred to as overburden.

MEMBERS. In the usage of the U.S. Geological Survey, a division of a formation, generally of distinct lithologic character or only local extent.

METER. The basic metric unit of lengths; one meter is equivalent to 3.28 feet.

MILLIDARCY. The customary unit of measurement of permeability equal to one-thousandth of a darcy.

MIXING HEIGHT. The height above the ground to which turbulence causes the air to be well mixed.

MULTIPLE POINT BOREHOLE EXTENSOMETERS. An instrument used for measuring small movement within a rock mass at several points in a single borehole.

NAHCOLITE. A white sodium bicarbonate, $NaHCO_3$. Small prismatic crystals.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS). Federal standards which establish the absolute national limits for pollutant concentrations.

NATURAL AREA. A physical and biological area that either retains or has reestablished its natural character, although it need not be completely undisturbed, and which typifies native vegetation and associated biological and geological features or provides habitat for rare or endangered animal or plant species or includes geologic or other natural features of scientific or educational value.

NODULE. Nonregular bodies of contrasting composition from the matrix in which they are embedded.

OIL SHALE. A layered sedimentary rock that contains abundant quantities of an organic material known as kerogen. When heated above 900°F, the kerogen in the rock decomposes, releasing a liquid oil product, shale oil.

OSMOTIC POTENTIAL. The component of the total water potential that lowers the free energy of water because of the presence of solutes in solution. The presence of solutes lowers the free energy of the water solution below that of pure free water because their presence increases the entropy of the total system.

OUTSTANDING NATURAL AREA. An area established to preserve scenic values and areas of natural wonder, as defined in 43 CFR 2071.1 and 43 CFR 6225.0-5. The preservation of these sources in their natural condition is the primary management objective.

OVERBURDEN. Designated as material of any nature, consolidated or unconsolidated, that overlies a deposit of useful material.

OVERSTORY. The upper canopy or canopies of plants. Usually refers to trees, tall shrubs, and vines.

PARENT MATERIALS. Soil parent materials are a result of the products of weathering processes, occurring on a layer or mantle of unconsolidated material which may or may not be derived from the underlying consolidated or partially weathered bed rocks. This surface of unconsolidated material is further modified to form soil.

PASTURE. A subdivision of a grazing allotment on public lands. The number of pastures is variable between allotments.

PERCOLATION. The slow seepage of water through soils or porous deposits.

PERMEABILITY. The capacity for transmitting a fluid.

pH. A measure of the acidity or alkalinity of a solution. Water is considered to be neutral at a pH of 7, acidic if pH is less than 7, and basic if greater than 7.

PIEZOMETRIC HEAD. The height to which water from a given aquifer will rise under its full head.

PLANT COVER. The percentage of an area covered by any part of living plant material (aerial plant cover), or that percentage of an area occupied by the portion of living plants at the point of emergence from the ground (basal plant cover).

POLLUTANT. Any gaseous, chemical, or organic waste that contaminates air, soil, or water.

POLLUTION. The contamination of soil, water, or the atmosphere by the discharge of noxious substances.

POROSITY. The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of openings in a rock to the total volume of the rock.

PRECIPITATE. A substance separated from a solution or suspension by chemical or physical change, usually as an insoluble amorphous or crystalline solid.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD). The management concept of establishing more stringent pollution increment levels in areas with clean air. PSD increments limit the amount of additional sulfur dioxide and total suspended particulate concentrations. Geographic areas are divided into three classes—each allows different increments of TSP and SO_2 concentration increases.

CLASS I - Minimal additional deterioration in air quality (certain national wilderness areas). CLASS II - Moderate additional deterioration in air quality (most lands).

CLASS III - Greater deterioration for planned maximum growth (industrial areas).

PRIME FARMLAND. In general, prime farmlands in Colorado have an adequate and dependable water supply from irrigation (a dependable water supply is one in which enough water is available for irrigation in 8 out of 10 years, for crops commonly grown), a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for long periods of time and they either do not flood frequently or are protected from flooding.

RAPTOR. Birds of prey with sharp talons and strongly curved beaks; e.g., hawks, owls, eagles, falcons.

REACH. A straight portion of a stream or river.

RECHARGE. The processes by which water is absorbed and added to the zone of saturation, either directly into a formation or indirectly by way of another formation; also the quantity of water that is added to the zone of saturation.

RECREATION DAY. The presence of one person on an area of land or water for the purpose of engaging in one or more recreational activities during all or part of a calendar day.

RECREATION OPPORTUNITY CLASSES:

PRIMITIVE (P). Areas lying more than 3 miles from the nearest point of motor vehicle access, having unmodified landscapes, where there are little evidence of other people, and that are almost completely free of management controls. (None in the planning area.)

SEMIPRIMITIVE NONMOTORIZED (SPNM). Areas at least one-half mile from the nearest point of motor vehicle access but not as distant as 3 miles, having mostly natural landscapes, where there are some evidence of other people, and where there are very few management controls. (None in the planning area.)

SEMIPRIMITIVE MOTORIZED (SPM). Areas alongside or near four-wheel drive roads and trails, having mostly natural landscapes, where there are often evidences of other people but numbers seen remain low, and where management controls are evident but not dominant.

ROADED NATURAL (RD). Areas alongside or near improved roads where pickups and sedans can be driven, having naturally appearing but modified landscapes, where there are moderate evidences and numbers of other people, and where management controls provide a sense of security.

RURAL (R). Areas alongside or near paved highways, or having heavily modified landscapes, where there may be considerable evidences or numbers of other people, and where management controls are easily seen.

MODERN URBAN (MU). Areas alongside or near paved highways, or where the natural landscape is dominated or replaced by man-made developments, where there are great numbers or evidences of other people, and where management controls are numerous and dominant.

RECREATION OPPORTUNITY SPECTRUM (ROS). A continuum used to characterize recreational opportunities in terms of setting, activity, and experience opportunities.

REMNANT VEGETATION ASSOCIATION. A plant community which has become established through successional sequences without interference by man and is an expression of the relative degree in which the kinds, proportions and amounts of the plant community may have resembled that of the original natural community.

RILL. A small intermittent water course with steep sides, less than 6 inches deep.

RIPARIAN. Situated on or pertaining to the bank of a river, stream, or other body of water. Normally used to refer to the plants of all types that grow rooted in the water table of streams, ponds, and springs.

ROCK MECHANICS. The theoretical and applied science of the mechanical behavior of rocks concerned with the response of rocks to the forces of their physical environment.

ROOM AND PILLAR MINING. A system of mining by supporting the roof with pillars left at regular intervals.

SALINE. Applied to minerals having a taste of common salt.

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SALINE ZONE. That portion of the Green River Formation lying beneath the dissolution surface and containing disseminated nahcolite, bedded halite and nahcolite interbedded with oil shales.

SECONDARY IMPACTS. See INDIRECT IMPACTS.

SEDIMENT. Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, or ice and has come to rest on the earth's surface either above or below sea level.

SEDIMENTARY. A descriptive term for rock formed of sediment, especially clastic rocks, as conglomerate, sandstone, and shales, formed of fragments of other rock transported from their sources and deposited in water.

SENSITIVE SPECIES. A species included on the sensitive species list developed by the Colorado State Office pursuant to section CL of Instruction Memorandum No. 80-722 and approved by the State Director. These lists will generally include any species in the state which meet any of the following criteria:

a. Candidate species are any species not yet officially listed but which are undergoing a status review or are proposed for listing according to *Federal Register* notices published by the Secretary of the Interior or the Secretary of Commerce.

b. Rare or infrequent species whose populations are consistently small and widely dispersed, or whose ranges are restricted to a few localities, such that any appreciable reduction in numbers, habitat, or habitat condition might lead toward extinction.

c. Other species whose numbers are declining so rapidly that official listing may become necessary as a conservation measure. Declines may be the result of one or more of several factors including: overuse for commercial, scientific, or educational purposes; disease, predation, or grazing; the inadequacy of existing regulatory mechanisms; and/or other natural or human factors adversely affecting the species continued existence.

SEQUENCE. The order in which events are connected or related in time; simple succession.

SODIUM ADSORPTION RATIO (SAR). A relation between soluble sodium and soluble divalent cations that can be used to predict the exchangeable-sodium percentage of soil equilibrated with a given solution. It is defined as follows:

SAR = sodium, mmoles per liter÷ (calcium + magnesium)$^{1/2}$ (mmoles per liter)$^{1/2}$

Surface Area. The surface area of soil, usually expressed as square meters per gram.

SPECIES. An organism which is, and remains, distinct because it does not normally interbreed with other organisms.

SPECIFIC CONDUCTANCE. See ELECTRICAL CONDUCTIVITY.

SPHERICAL ATTENUATION. The reduction in sound level which occurs for point sources due to the spherical spreading (divergence) of sound waves eminenting from the source. Under normal conditions this attenuation is equal to a reduction of 6 dB per doubling of distance. In other words, if a point source produces a sound level of 66 dB at a distance of 50 meters, at 100 meters the sound level will be 60 dB.

STATEWIDE IMPORTANT FARMLANDS. Lands that do not meet the requirements for prime farmlands but are still of statewide importance for the production of food, feed, fiber, forage, and oil seed crops. Categories include: 1) irrigated lands (not prime), 2) irrigated lands (water supply inadequate), and 3) high potential dry cropland.

STORAGE COEFFICIENT. The volume of water released from storage in a unit prism of an aquifer when the head is lowered a unit distance.

STRATA. Sedimentary rock layers.

STRATIGRAPHY. Descriptive geology of an area or district that pertains to the discrimination, character, thickness, sequence, age, and correlation of the rocks.

STRUCTURAL BASIN. Formed by the force within the earth bending the crust down between mountain ridges, giving rise to depressions called structural basins.

SUBSIDENCE. The lowering of the strata, including the surface, because of underground excavations.

SYNOPTIC. Weather patterns associated with high and low pressure systems in the lower troposphere.

THREATENED SPECIES. Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

TONGUE. Part of a geologic formation that is known to wedge out laterally.

TOPOGRAPHY. The exact physical features and configuration of a place or region; the detailed and accurate description of a place or region.

TOPSOIL. Fertile soil or soil material, usually rich in organic matter, used to top-dress disturbed areas. Topsoil is better suited to supporting plants than other material.

TOTAL DISSOLVED SOLIDS. Solids that originate mostly from rocks and are in solution. Some colloidal material is treated as if it were in solution in determining dissolved solids. The total dissolved mineral constituents of water.

TOTAL SUSPENDED PARTICULATES (TSP). The portion of the total particulate matter in the atmosphere consisting of particles that are nominally less than 30 microns in diameter.

TRACT C-A. One of two federal oil shale lease areas in Colorado. The area is 5,120 acres in size, and is leased to Gulf Oil Corporation and Standard Oil Company (Indiana).

TRACT C-B. The second of two federal oil shale lease areas in Colorado. This area is leased by Occidental Oil Shale Corporation and Tenneco Shale Oil Company.

TRANSIENT/TRANSITORY. Lasting or staying only a short time.

UBIQUITOUS. Constantly encountered.

UNDERSTORY. Plants growing beneath the canopy of other plants. Usually refers to grasses, forbs, and low shrubs under a tree or brush canopy.

UNIQUE FARMLAND. Unique Farmland is land other than Prime Farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yield of a specific crop, when treated and managed according to acceptable farming methods. In Colorado only fruit orchards and vegetable producing areas of high production are considered unique.

VEGETATION TYPE. A plant community with immediately distinguishable characteristics, based upon and named after the apparent dominant plant species.

VISIBILITY. A measurement of air clarity, normally the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

VISUAL RESOURCE MANAGEMENT CLASSES. The degree of acceptable visual change within a characteristic landscape. A class is based upon the physical and sociological characteristics of any given homogeneous area and serves as a management objective.

CLASS I. Areas (preservation) provided for natural ecological changes only. This class includes primitive areas, some natural areas, some wild and scenic rivers, and other similar sites where landscape modification activities should be restricted.

CLASS II. (Partial retention of the landscape character) includes areas where changes in any of the basic elements (form, line, color, or texture) caused by a management activity should not be evident in the characteristic landscape.

CLASS III. (Partial retention of the landscape character) includes areas where changes in the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing characteristic landscape.

CLASS IV. (Modification of the landscape character) includes areas where changes may subordinate the original composition and character; however, they should reflect what could be a natural occurrence within the characteristic landscape.

CLASS V. (Rehabilitation or enhancement of the landscape character) includes areas where change is needed. This class would apply to areas where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short-term classification until one of the other classes can be reached through rehabilitation or enhancement.

VUG. A small cavity in a rock, often with a mineral mining of different composition from that of the surrounding rock.

WATERSHED. The region draining into a river, river system, or body of water.

WINTER RANGE. The range or habit on which wildlife spend the winter (December 15 to March 15). Based on an average of five winters out of 10.

XERIC. Characterized by, relating to, or requiring only a small amount of moisture.

7.1 List of Abbreviations

ACEC. Area of Critical Environmental Concern
acre-ft/year. Acre-feet per year
AMC. Advance Minerals Corporation
AQRV. Air Quality Related Value
ASTM. American Society for Testing and Materials
AUM. Animal unit month
BACT. Best Available Control Technology
bbl/day. Barrels per day
BCF. Billion cubic feet
cfs. Cubic feet per second
BLM. Bureau of Land Management
BOM. Bureau of Mines
BPSD. Barrels per stream day
Btu. British thermal unit
CDOW. Colorado Division of Wildlife
CEQ. Council on Environmental Quality
CFR. Code of Federal Regulation
CITF. Cumulative Impact Task Force
CO. Carbon monoxide
CPS. Cathodic Protection Station
CSMRI. Colorado School of Mines Research Institute
CSU. Colorado State University
dB. Decibel
DDP. Detailed development plan
EA. Environmental Assessment
EC. Electrical Conductivity
EIS. Environmental impact statement
EPA. Environmental Protection Agency
FLPMA. Federal Land Policy and Management Act
gpm. Gallons per minute
IRI. Industrial Resources, Inc.
MFP. Management Framework Plan
mg/l. Milligram per liter
MMC. Multi-Minerals Corporation
NAAQS. National Ambient Air Quality Standards
NEPA. National Environmental Policy Act
NO$_2$. Nitrogen dioxide
NO$_x$. Nitrogen oxide
NRHP. National Register of Historic Places
O$_3$. Ozone
OSHA. Occupational Safety and Health Act
pcf. Pounds per cubic foot
PM$_{10}$. Particulate matter less than 10 microns in diameter
PSD. Prevention of Significant Deterioration
psi. Pounds per square inch
psig. Pounds per square inch gauge
RBC. Rio Blanco County (road)
RMP. Resource Management Plan
ROS. Recreation Opportunity Spectrum
RVA. Remnant Vegetation Association
SCS. Soil Conservation Service
SHPO. State Historic Preservation Officer
SO$_2$. Sulfur dioxide
T/E. Threatened and Endangered Plant or Animal Species
TAPAS. Topographic Air Pollution Analysis System
TDS. Total Dissolved Solids
tpy. Tons per year
TSP. Total Suspended Particulates
ug/m$_3$. Micrograms per cubic meter
USDI. United States Department of the Interior
USFWS. United States Fish and Wildlife Service
USGS. U.S. Geological Survey
USP. U.S. Pharmaceutical
VRM. Visual Resource Management
WRC. Wolf Ridge Corporation
WRRA. White River Resource Area

8. REFERENCES

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